

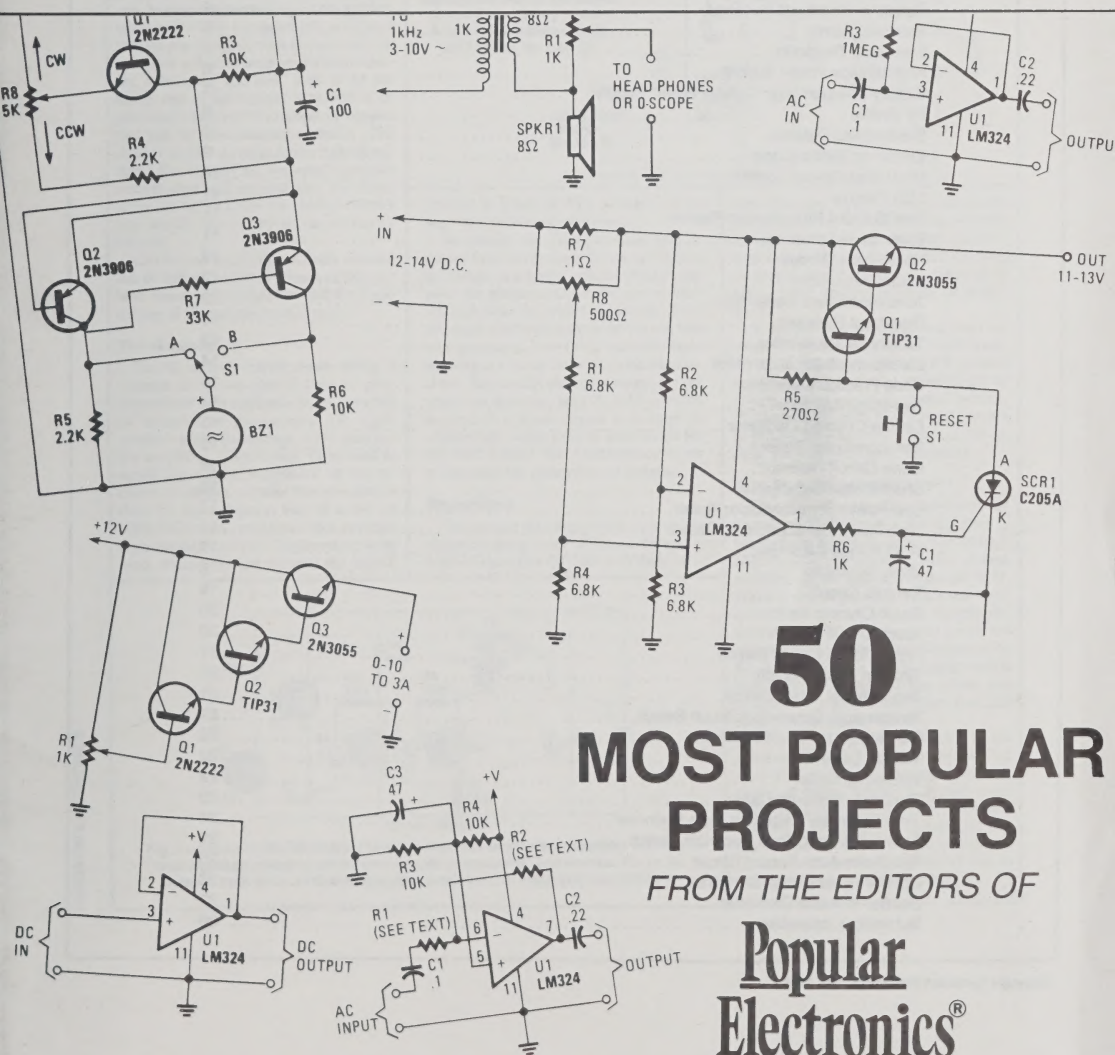
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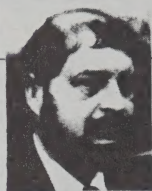
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Q1
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By Charles D. Rakes

CIRCUIT CIRCUS





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CIRCUIT CIRCUS

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CIRCUIT CIRCUS

By Charles D. Rakes

Infrared—The silent sound

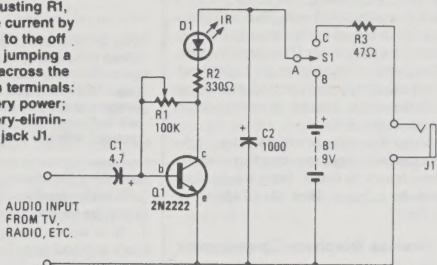
□CIRCUIT CIRCUS IS ESPECIALLY WRITTEN for and directed toward you, the electronics experimenter, who enjoys building a new circuit without its cost adding to the national debt. It doesn't matter whether you do your experimenting on the kitchen table or in a fully equipped lab, we intend to keep you supplied with *inexpensive* circuits that will help keep your experimenting habit *alive* and *well*. And if we get lucky, one of the circuits is certain to be just what's needed for that special project that you've been wanting to build. (The project needed a nudge in the right direction.) But most of all, we want to present circuits that will interest *you*; so please write and let us know the kind of circuits you would like to see in our *circus* of circuits.

Our first series of circuits deals with the use of *infrared*—better known as IR—for both voice communication and the basic testing of IR remote-control units.

The Receiver

The IR receiver circuit shown in Fig. 1 consists of Q1—a special kind of phototransistor that responds to an intensity of amplitude-modulated IR light source—and a three-stage, high-gain audio amplifier. Transformer T1 is used to match the output impedance of the receiver to today's popular low-impedance (low-Z) headphones; but if a set of 1000-2000-ohm, magnetic (not crystal), high-impedance (high-Z) phones are to be used, remove T1 and connect the high-Z

Fig. 2—When adjusting R1, measure the diode current by setting switch S1 to the off position and then jumping a DC-milliammeter across the appropriate switch terminals: A and B for battery power; A and C for battery-eliminator power via jack J1.



phones in place of T1's primary winding—the 1000-ohm winding.

To obtain the best possible performance from the receiver the circuit should be housed in a small, opaque-plastic case with the phototransistor located at least 1/2-inch from one end of the cabinet. Drill or punch a 1/4-inch hole in the case in line with phototransistor Q1 so that only light arriving in a direct line can strike the transistor. Because IR phototransistors are not perfect in detecting only IR light—and do respond in a lesser degree to a range of visible light—this kind of installation for Q1 will reduce the interference from lamps used for general room lighting.

Experiment

To increase the range of the receiver try experimenting with different filters in front of transistor Q1, and with lenses that

focus the light on the sensitive area of the phototransistor. With the proper light filter and lens system the receiver's range of detection can be several hundred feet; but, as shown, it will receive at a range of 40 feet or more depending on the IR source used.

A simple way to check out your receiver before building one of the IR transmitters is to locate a TV or VCR infrared remote-control unit, aim it toward the receiver, and hit any of its control buttons. You should instantly hear a rapid number of pulses, or a buzzing sound, as the remote spits out its digital command.

Your Own Broadcaster

The ultra-simple one-transistor, IR transmitter shown in Fig. 2 is designed to transmit the sound from any 8 or 16-ohm audio source, such as a TV, radio, or tape recorder on an infrared beam of light. While it can be powered by a 9-volt transistor-radio battery, you can sharply decrease battery-replacement costs by substituting a 9-volt battery eliminator for B1. Switch S1 is a small toggle switch with a center-off position that allows you to operate the transmitter either from the battery or the power line.

Since battery eliminators vary in the amount of output ripple, capacitor C2 should be made large enough to take care of the problem. Resistor R3 helps to reduce the ripple and could be increased somewhat in value. Those are just two more areas in which you can experiment to determine the best method of use to obtain the best possible results.

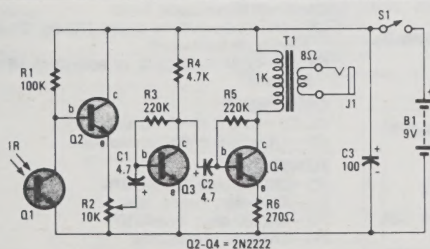


Fig. 1—Basically, the IR receiver is a conventional three-stage amplifier with the input signal provided by an infrared sensitive transistor. Transformer T1 can be replaced by a 1000-2000-ohm magnetic earphone, or magnetic headphones.

The circuit can be housed in a small plastic case with potentiometer R1 mounted inside, because once you determine its setting, it will not need re-adjusting. The desired input cables or jacks needed to match those of the audio source can be mounted on the case.

To increase the operational range of the IR transmitter, try experimenting with different lenses to better direct the light toward the receiver. How about adding an IR filter?

The IR transmitter circuit in Fig. 3 connects to your telephone circuit, and, at no cost to you, transmits both sides of all telephone conversations to any line-of-sight location within 40 feet. Now that's

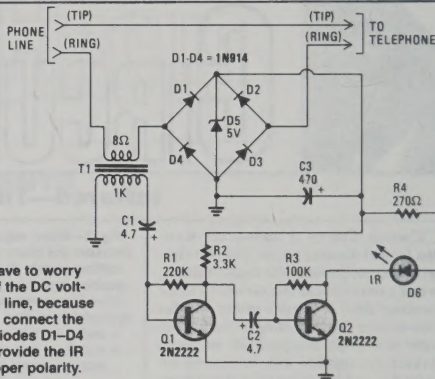


Fig. 3—You don't have to worry about the polarity of the DC voltage on the telephone line, because regardless how you connect the project to the line diodes D1-D4 will automatically provide the IR project with the proper polarity.

To understand just how we got *Ma Bell* to pay the freight, take a close look at Fig. 3. In a normal telephone circuit, two wires (tip and ring) carry all of the information and operating voltages from the central telephone office to your phone's location. A DC source of 48 volts is supplied to the tip and ring wires going to your home from the telephone company's

The phone wires into your home are called tip and ring; their original operator

(Continued on page 28)

Q1—Infrared Photodetector (Radio Shack Cat. 276-142, or equivalent)
Q2, Q3, Q4—2N2222, 2N5249, or equivalent, NPN silicon transistor

C1, C2—4.7- μ F, 16-WVDC, electrolytic
C3—100- μ F, 16-WVDC, electrolytic

R1—100,000-ohm, 1/4-watt, 10%
R2—10,000-ohm, linear-taper potentiometer
R3, R5—220,000-ohm, 1/4-watt, 10%
R4—4700-ohm, 1/4-watt, 10%
R6—270-ohms, 1/4-watt, 10%

T1—Miniature audio transformer; 1000-ohm primary, 8-ohm secondary
J1—Phone jack, open-circuit
B—9-volt transistor-radio battery
S1—SPST toggle or slide switch
Low-Z headphones, small plastic case, battery snap, wire, solder, hardware, etc.

D1—Infrared-emitting diode (Radio Shack Cat. 276-142, or equivalent)
Q1—2N2222, 2N5249, or equivalent, NPN silicon transistor

C1—4.7- μ F, 16-WVDC, electrolytic

R1—100,000-ohm, linear-taper potentiometer
R2—330-ohm, ¼-watt, 10%
R3—47-ohm, ¼-watt, 10%

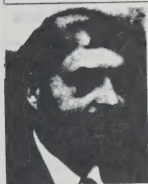
S1—SPST, center-off, toggle switch
B1—9-volt, transistor-radio battery
J1—Normally-open jack to match plug on power-supply cable
Plug-in power pack rated at 9-VDC at 200-mA, plastic case, wire, solder, hardware, etc.

D1-D4—1N914 silicon signal diode
D5—5-volt Zener diode, 1-watt
D6—Infrared-emitting diode (Radio Shack Cat. 276-142, or equivalent)
Q1, Q2—2N2222, 2N5249, or equivalent, NPN silicon transistor

C1, C2—4.7- μ F, 16-WVDC electrolytic
C3—470- μ F, 16-WVDC electrolytic

R1—220,000-ohm, ¼-watt, 10%
R2—3300-ohm, ¼-watt, 10%
R3—100,000-ohm, ¼-watt, 10%
R4—270-ohm, ¼-watt, 10%

T1—Miniature audio transformer, 1000-ohm primary, 8-ohm secondary.
Plastic case, wire, solder, perfboard, pins, hardware, etc.



By Charles D. Rakes

Circuit Circus

Unring those bells and other telephone tricks

THIS MONTH WE WILL LOOK AT SEVERAL uncomplicated and inexpensive circuits to use in conjunction with your telephone system. Any way that it's possible to add benefits to your basic telephone service without causing an increase in the monthly bill is definitely a plus in the never-ending struggle against the billion-dollar utility companies; so scrutinize each of these circuits and build one that will give you an extra telephone function for free.

A brief look into the basic telephone system at the subscriber's end will help you to understand and use these circuits. A pair of wires connects each phone (including all extension phones with the same calling number) to the equipment housed in the telephone's central office. One of the two wires is green in color; it's referred to as the *TIP*, or *T*, and is normally positive. The other line is usually red and is called the *RING*, or *R*, and is negative. The central office supplies 48-VDC to the phone line that supplies most power needs at the subscriber's end.

Until the phone is taken off-hook the 48-volts remains on the line, but it drops to 10-volts or less when the phone goes off-hook. Always double-check the phone's line voltage and polarity with a DC-voltmeter, and don't be too surprised if the polarity and wire color coding are reversed. Our old friend "Murphy" could be at work at your local telephone company, too, so be careful.

Ring Them Bells

Have you ever had the ringing of the phone undo your day? Like when you're sacked out after a long day in the salt mine and some clown calls to check on the

condition of Prince Albert in his can. (For some reason children never cease to find this funny—at 2 A.M.) If so, the circuit shown in Fig. 1 can solve the problem by replacing the ringer with a 117-VAC lamp; instead of *ring ring*, a *blink blink* lets you know someone's trying to get you.

On the other hand, should you need something louder than a conventional telephone bell to get attention, you can use the same circuit to activate a 117-VAC bell or gong—and no one is going to ignore that kind of noise.

Figure 1 works this way: If, a small neon lamp which is triggered into conduction by the telephone's ringing voltage, passes just enough current to activate the LED in optocoupler U1, which in turn triggers the 6-A Triac that controls I2—a 117-VAC lamp or bell. (Capacitor C1 is necessary only when the circuit is used to drive a bell.)

The circuit can be built on a small piece of perfboard and can be housed in a small plastic cabinet. Actually, you can use any assembly technique that you prefer; just keep the 117-VAC clear of the telephone line's wires.

PARTS LIST FOR FIG. 1

- C1—39-pF, 600-VDC disk capacitor
- D1—1N4002 1-A silicon rectifier
- I1—NE-2 neon lamp, or equivalent
- I2—20- to 100-watt 117-volt lamp
- P1—Power plug
- R1—10,000-ohm, ½-watt, 10%, resistor
- R2—220-ohm, ½-watt, 10%, resistor
- TR1—Triac, 400-WVDC, 6-A, Radio Shack 276-1000
- U1—MOC3010 Optoisolator/coupler, Radio Shack 276-134
- Wire, solder, cabinet, etc.

The actual operation is uneventful until a call comes in. If a lamp is used it will flash off-and-on at the ringing rate, which is normally around 20-Hz. If you are in sight of the lamp you will certainly not miss a call. Oh, by the way, you will need to turn off the telephone's ringer (look on the underside of the phone) if you don't want both sight and sound coming on at the same time.

If a 117-VAC bell is used, connect it in place of the lamp.

Phone to Switch

Figure 2 is a line-activated solid-state switch. Each and every time a phone on the same line or calling number is taken off-hook the circuit will be activated to control an external electronic circuit.

If several extension telephones are used on one phone line, the circuit can be useful as a "busy" indicator, especially if you have a teenager living at home. LED1 contains a special flashing red LED that makes an excellent indicator for a "busy" circuit condition. A line-activated solid-state switch can be used for each of the extension phones so everyone can have the advantage of knowing when the line is open for use. The solid-state switch can be used for several other phone activated applications, such as automatically turning on a cassette recorder, starting a phone-use timer, a phone-use counter, etc. A small relay can be connected at points "A" and "B," in place of LED1, to control external circuits.

A 117-VAC-to-6-VDC plug-in power supply can be substituted for the battery to keep the operating cost at a minimum.

The 48-VDC on-hook phone-line volt-
(Continued on page 29)

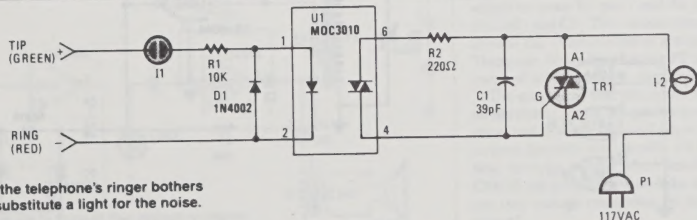
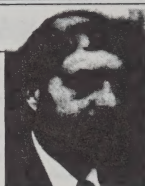


Fig. 1—If the noise of the telephone's ringer bothers you, this circuit will substitute a light for the noise.



By Charles D. Rakes

CIRCUIT CIRCUS

Putting digital devices into the "Twilight Zone"

THIS MONTH OUR *CIRCUIT CIRCUS* TAKES you to a three-ring event that places a couple of digital CMOS IC's in circuits that operate in the "Twilight Zone,"—somewhere between the norm and extra-terrestrial. (It's always more fun to experiment with a circuit that doesn't flow down the middle of the road.)

The first project, shown in Fig. 1, places one-quarter of a CMOS quad 2-input NOR gate, a 4001A, in the heart of our *Super-Simple-Dyne* broadcast receiver circuit. Don't let the simplicity of the circuit discourage you from building the receiver; its performance will rival the best of the one or two transistor-radio circuits. Even in my remote rural area, by using a short 33-inch telescopic antenna we received four stations loud and clear during daylight hours. Connecting 10 feet of hookup wire to C1 brought in several additional stations.

Since the component layout isn't critical you can build the receiver on a 5- x 5-in. section of perforated wiring board (*perfboard*).

Almost any kind or quality of ferrite loop-stick antenna coil will work for L1, but the small adjustable type is best. L2 is a secondary winding added to L1 by winding 10-turns of #26 enameled copper wire, in a solenoid fashion, around the center of the loopstick. Make certain that you leave the leads at least 3-in. long.

Tape the secondary in place with ordinary plastic electrical tape.

Use a 14-pin integrated-circuit socket

PARTS LIST FOR FIGURE 1

SEMICONDUCTORS

D1, D2—Silicon diode, 1N914, or equivalent

U1—4001A, CMOS quad 2-input NOR gate integrated circuit

CAPACITORS

C1—22-pF, 50-WVDC ceramic disc

C2—365-μF tuning capacitor

C3, C4—0.1-μF, 50-WVDC Mylar

C5—0.02-μF, 50-WVDC Mylar

C6—100-μF, 16-WVDC electrolytic

C7—39-pF, 50-WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery

J1—Phone jack

L1—Ferrite loopstick antenna, see text

R1—10,000-ohm, 1/4-watt, 10%, resistor

R2—50,000-ohm, miniature potentiometer, see text

S1—SPST switch

Misc.—2000-ohm headphones, *perfboard*, IC socket, hardware, wire, solder, etc.

for the 4001A, and tie all unused gates to battery negative, as shown in Fig. 1.

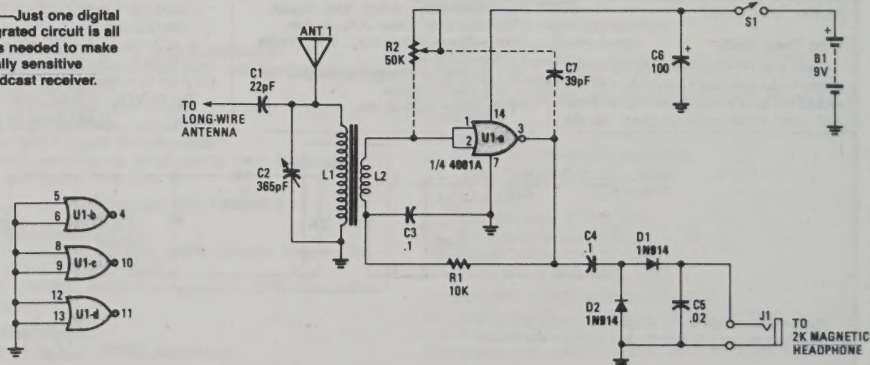
If the receiver doesn't work and the wiring checks out OK, try reversing the leads on L1's 10-turn secondary. Also, make certain that the headphones are 2000 ohms or higher; the low impedance "hi-fi" type won't work.

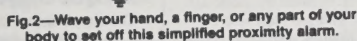
The receiver circuit is operating at a very high level of gain and may tend to go into oscillation. If it does, add the components indicated by the dotted lines—C7 and R2—and adjust R2 for the best reception. You can experiment by: changing the number of turns on the secondary of L1; making C1 a variable capacitor to match a much longer antenna for receiving DX; using a 4001B in the circuit; adding an audio amplifier to the receiver.

Don't Get too Close

The second "not-by-the-book" circuit, shown in Fig. 2, places a CMOS hex inverting buffer (a 4049) in the middle of a sensitive proximity-alarm project. Inverters U1a and U1b are connected in a simple RC oscillator circuit. The frequency is determined by the values of R1, C1, C2, and the internal characteristics of the integrated circuit. As long as the circuit is oscillating, a positive DC voltage is developed at the output of the voltage-doubler circuit: C3, D1, D2, and C4. That DC voltage is applied to the input of U1c—the

Fig.1—Just one digital integrated circuit is all that's needed to make a really sensitive broadcast receiver.

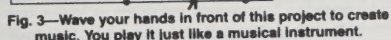


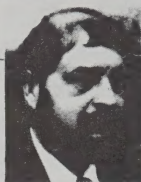


As an experiment, you might try several different metal objects (in size and shape) for the pickup plate. You might also try replacing BZ1 with a small relay and use the circuit with an existing burglar-alarm system.

The electronic Theremin circuit shown in Fig. 3 has the CMOS IC from Fig. 2 doing double-duty performance. The first two inverters operate as a digital audio

T1—Transformer, audio output, 1000-ohm primary, 8-ohm secondary
Perfboard, pins, wire, solder, light source, etc.





By Charles D. Rakes

CIRCUIT CIRCUS

It doesn't take much to generate enough high voltage to curl your hair

THIS MONTH'S CIRCUIT SELECTIONS are for the experimenter having a touch of Ben and Nikola's fascination for working with high voltage. But unlike these two brave pioneers who flirted with lightning and gigantic spark coils, our high voltage circuits are mild in comparison, having outputs of less than 50-kV. Even so, don't ever become careless when working with high voltage: To do so could be dangerous to your health and your good nature. So please take care.

The circuit shown in Fig. 1 generates a high voltage by discharging the energy stored in a large value capacitor through the primary winding of a high-turns-ratio step-up transformer. This method of producing high voltage is known as a *capacitor discharge system*. It's the same concept used by many of the high performance auto-ignition systems to produce a super-hot spark. It's also the same kind of system used by some of the top-of-the-line electric fence chargers. And not to forget one of the most popular personal-defense devices to be found in the marketplace: the electronic *Stun Gun*, which also generates its zap with a capacitor-discharge circuit.

How We Make the Zap

As shown in Fig. 1, stepdown trans-

former T1 drops the incoming line voltage to approximately 48-VAC, and in the process adds a degree of safety through the transformer's primary-to-secondary isolation from the powerline. T1's 48 volt secondary voltage is rectified by diode D1; the resultant DC charges capacitor C1—through current limiting resistor R1—to a voltage level pre-set by R4. When the voltage on R4's wiper reaches about 8.6 volts, Q1 begins to turn on, drawing current through R7 and the base-emitter junction of Q2. Q2 turns on and supplies a positive voltage to the gate of silicon-controlled rectifier Q3. The positive gate voltage causes Q3 to conduct, thereby discharging C1 through the primary winding of step-up transformer T2, which results in a high voltage arc at the output terminal (X).

The value of the high voltage developed at T2's output is determined by the value of C1, the voltage across C1, and the turns ratio of transformer T2.

The frequency or pulse rate of the high voltage is determined by the resistance of T1's primary and secondary windings, the value of R1, and the value of C1. The

lower the value of each item the higher the output pulse rate, but the peak output voltage will only remain unchanged if C1's value remains unchanged.

Building the CD System

The circuit shown in Fig. 1 is non-critical, so any parts layout and mounting can be used; in particular, perforated wiring board will probably make for the easiest assembly. But no matter what kind of construction is used, keep T2's output terminal (labeled X) at least three inches clear of all circuit components, yourself, and anything else that can conduct electricity.

The transformer used for T2 can be almost any 6 or 12 volt auto-ignition coil, but one designed with a high turns ratio for a capacitor-discharge ignition system will produce the greatest output voltage. The CD coil that we used produced a spark 1-3/4 inches in length from the output terminal to the coil's common terminal.

An old (but good) TV flyback transformer can also be used for T2. Simply wind about 10 turns of test-lead wire around the transformer's ferrite core and connect the free ends of the wires to the

PARTS LIST FOR FIG. 1

SEMICONDUCTORS

- D1—1N4003, 1-A, silicon rectifier
- D2—1N756, 8-volt Zener diode
- Q1—2N2222 NPN transistor
- Q2—2N3638 PNP transistor
- Q3—Silicon-controlled rectifier, 6-A, 200-VDC

RESISTORS

(All fixed resistors 1/2-watt, 5% fixed units, unless otherwise noted.)

- R1—100-ohm, 5-watt
- R2, R5—3300-ohm
- R3—10,000-ohm
- R4—10,000-ohm, linear-taper potentiometer
- R6—33,000-ohm
- R7—15,000-ohm
- R8—100,000-ohm
- R9—2200-ohm

ADDITIONAL PARTS AND MATERIALS

- C1—220 or 440-μF, 75 to 100-WVDC electrolytic capacitor
- T1—Transformer: AC-line step-down, power; 48-VAC, 300-mA
- T2—Auto-ignition coil, also other types, (see text)

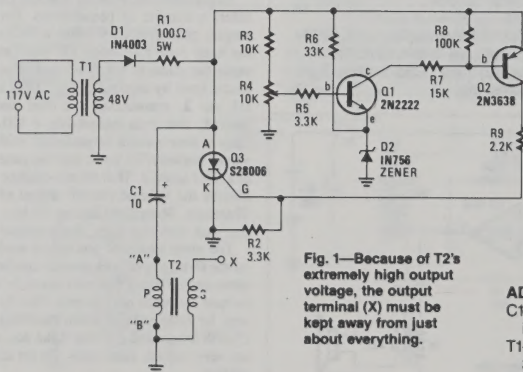


Fig. 1—Because of T2's extremely high output voltage, the output terminal (X) must be kept away from just about everything.

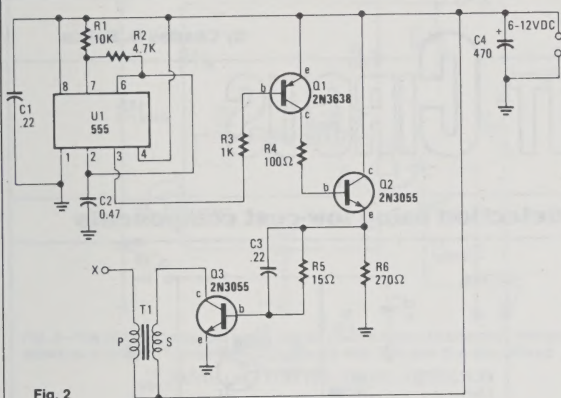


Fig. 2

PARTS LIST FOR FIG. 2

SEMICONDUCTORS

- Q1—2N3638 PNP transistor
- Q2—2N3055 NPN power transistor
- Q3—2N3055 NPN transistor with heat sink.
- U1—555 timer integrated circuit

CAPACITORS

- C1, C3—0.22-µF, 100-WVDC Mylar capacitor
- C2—0.47-µF, 100-WVDC Mylar capacitor
- C4—470-µF, 25-WVDC electrolytic capacitor

RESISTORS

(All resistors ½-watt, 5% fixed units, unless otherwise noted.)

- R1—10,000-ohm
- R2—4700-ohm
- R3—1000-ohm
- R4—100-ohm
- R5—15-ohm, 5-watt
- R6—270-ohm

ADDITIONAL MATERIAL

- T1—Auto-ignition coil (see text)

points labeled "A" and "B" in Fig. 1. Some experimenting with the number of turns may be necessary to obtain good results with this type of transformer. Our experiments with the TV flyback produced a voltage that would jump a ¾-inch gap.

If a small-engine repair business is located in your area, see if the owner or mechanic will give you a few of the old ignition coils. Hopefully, if several coils are obtained, one or more will be usable. To produce high voltage with a small-engine ignition coil, connect the primary leads to terminals "A" and "B," and a ½-to ¾-inch spark should be possible.

To make a "magnetic charger," select one of the ignition coils that has a good primary winding and carefully remove the secondary winding from the coil's core. Connect the primary wires to terminals "A" and "B." Position any object that you want to magnetize on the exposed core laminations and apply power: *Zap-Zap!* is the sound you should hear as the magnetic pulses hit the metal object.

To Smack of Spark

For maximum spark select a CD ignition coil and use a 440-µF, 75- to 100-WVDC electrolytic capacitor for C1. Using a DC voltmeter, monitor the voltage across C1. Adjust R4 so that the Q3 fires when the charging voltage across C1 reaches 50 to 55 volts. This setting should produce a spark ¼-to 1½ inches long every second or so.

To obtain a faster pulse rate—with some reduced output—change C1 to a 10-µF, 220-VAC motor capacitor (or any other lower value with a rating of 75 volts or more). Experiment with different component values to obtain the desired results.

An excellent electric fence charger can be made by building the CD circuit in a suitable case and selecting a 220-µF capacitor for C1. Adjust R4 for a range of one to two pulses per second.

Battery-Powered High Voltage

A high-voltage generator circuit that can operate from a battery or other low-voltage DC source is shown in Fig. 2. Output voltage great enough to jump a 1-inch gap can be obtained from a 12 volt power source, and with a higher pulse rate than the one from the circuit shown in Fig. 1, but it operates as well.

It's Timer Controlled

A 555 timer integrated circuit is connected as an astable multivibrator that produces a narrow negative pulse at pin 3. The pulse turns Q1 on for the duration of the time period. The collector of Q1 is direct-coupled to the base of the power transistor Q2, turning it on during the same time period.

The emitter of Q2 is direct-coupled through current limiting resistor R5 to the base of the power transistor. Q3 switches on, producing a minimum resistance between the collector and emitter. The high current pulse going through the primary of high voltage transformer T1 generates a very high voltage at its secondary output terminal (labeled X). The pulse frequency is determined by the values of R1, R2, and C2. The values given in the parts list were chosen to give the best possible performance when an auto-ignition coil is used for T1.

Here also, a CD-type ignition coil will produce the greatest output voltage.

Perforated wiring board construction is also a good choice for this, but here too, be careful when working around the out-

put terminal of T1 while the power is on.

Whether you build just one or both of this month's circuits, you're certain to get the same thrill and excitement as Franklin and Tesla did when they worked with high voltage.

On Getting Parts

To ensure that your time spent building a *Circuit Circus* project isn't wasted, as much as possible we try to design our circuits around devices which are themselves often used as "substitutes" for other types; or we use devices which are so commonly used that they are generally available from sources that cater to hobbyists as well as OEM's.

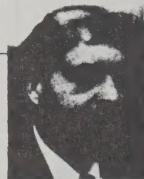
Naturally, Radio Shack is a prime source for components because there are so many Radio Shack stores. Unfortunately, the extent of their line of solid-state devices and even connectors is somewhat limited, and we can't often match our needs to their stock. So we move on to an even better stock distributor: that's Digi-Key Corp. (P.O. Box 677, Thief River Falls, MN 56701).

It's quite possible that you will need a powerful magnifier to read their ads, but just about any common electronic component used in one of our projects should be available from Digi-Key.

A good selection of unusual components—such as photo-flash capacitors and telephone transformers—can be obtained from All Electronics Corp. (905 S. Vermont, Los Angeles, CA 90006); and of course, Dick Smith Electronics Inc., P.O. Box 2249, Redwood City, CA 94063.

While you should get all the catalogs you can, if you get catalogs from at least these four sources you'll probably have no difficulty at all building your *Circuit Circus* projects. ■

By Charles D. Rakes



Circuit Circus

Signal and electrostatic detection using low-cost components

THIS MONTH I REACHED OUT TO TWO knowledgeable experts in the field of science and scientific investigation to aid me in bringing you the following specialized circuits that deal with electronic investigation and detection. In doing so, it's only proper to introduce those two distinguished gentlemen—the Honorable Professor H. V. Goodmeasure, PUD, of Hexrod University, and the renowned Master Detective, Sir Shedrock McBones, Esq., of Snoop International, Inc.—who've been so helpful in this and past projects. So if any good and honorable deeds come from using any of the circuits herewithin the credit must go to those two men.

The first circuit was suggested to me by Sir McBones, Esq., and was similar to the one he used to locate the misplaced satellite downed in the far cold north that, had it remained undiscovered, could have deactivated all of the flying reindeer in the region. Since the search area was so near to Santa's workshop and corral, it's easy to see the seriousness of the problem...but not to worry, McBones solved the case in short order and all flew well.

RF Path Finder

The circuit shown in Fig. 1, uses four different semiconductors to make up a sensitive *RF Sniffer* that's designed to locate lost or unauthorized transmitters or other sources of interfering RF energy. The Sniffer circuit responds to RF signals from below the standard broadcast band to well over 500 MHz, and provides a visual and audible indication when a signal is received. The circuit is designed to receive low-powered signals as well as strong sources of energy by adjusting the bias on the pick-up diode, D1, with R2. A very sensitive setting can be obtained by carefully adjusting R2 until the LED just begins to light and a faint sound is produced by the Piezo sounder.

A small piece of perfboard is a good choice to build the circuit on; just keep the leads on the front-end parts—D1, C1, C2, L1, R1, and R2—as short as possible, and use a good wiring scheme for the remaining circuitry. A small metal cabinet can be used to house the circuit and give an added degree of stability when used around

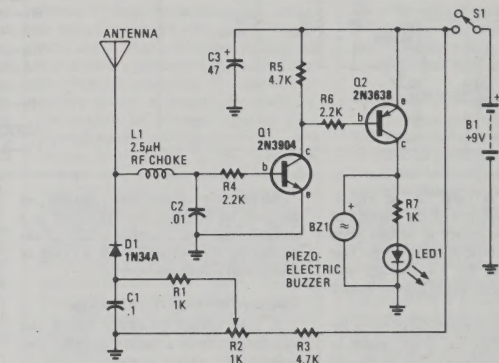


Fig. 1—The RF Sniffer locates transmitters or other sources of interfering RF energy by detecting RF from below the standard broadcast band to well over 500 MHz.

PARTS LIST FOR THE RF SNIFFER (FIG. 1)

B1—9-volt transistor radio battery.
BZ1—Piezo-electric buzzer (Radio Shack #273-065 or similar)
C1—0.1-µF, ceramic disc capacitor
C2—0.01-µF, ceramic disc capacitor
C3—47-µF, 16-WVDC electrolytic capacitor
D1—1N34A germanium signal diode
L1—2.5-µH RF choke (most any similar size will work)
LED1—Jumbo light-emitting diode
Q1—2N3904 NPN silicon transistor

Q2—2N3638 PNP silicon transistor
R1—1500-ohm, ¼-watt resistor
R2—1000-ohm, potentiometer
R3, R5—4700-ohm, ¼-watt resistor
R4, R6—2200-ohm, ¼-watt resistor
R7—1000-ohm, ¼-watt resistor
S1—Single-pole, single-throw (SPST) toggle switch
Misc: Telescoping antenna (20 to 26-inches long), perfboard, cabinet, wire, hardware, solder, etc.

high RF-signal sources; even though our Sniffer performed just fine without a metal case.

If a room or area is to be swept for a hidden low-power transmitter, set the sensitivity of the Sniffer to its maximum setting and extend the antenna to its full length.

Electrostatic Detector

The circuit offered in Fig. 2 (an FET Electroscope) is an exact copy of the one used by the Professor to seek out and discharge the dastardly *Staticman* that was only a single spark away from destroy-

ing a major semiconductor manufacturer located in that famous *Germanium Valley*.

Comb your hair and shuffle your feet, while waving your hand near the circuit's pick-up, and the meter will flip and flop indicating an *air* of charging static. One practical use for such a circuit is to test for static charges on tools, soldering irons, our hands, etc., when working with sensitive semiconductors that are very shy of anything that sparks.

The very heart of the Electroscope is the two junction field-effect transistors (JFET), Q1 and Q2, which are connected in a balanced-bridge circuit. The gate in-

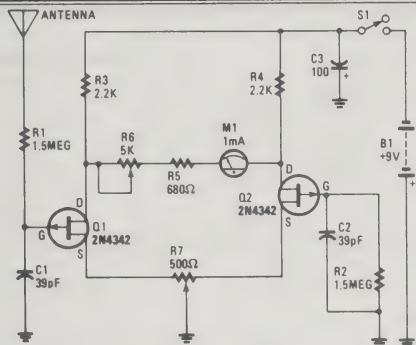


Fig. 2—The FET Electrostatic Detector, which can be used to detect electrostatic charges, is based on a dual JFET balanced bridge circuit, with Q1's gate to a wire pick-up.

PARTS LIST FOR THE STATIC DETECTOR (FIG. 2)

B1—9-volt transistor radio battery
C1, C2—39-pF, ceramic disc capacitor
C3—100- μ F, 16-WVDC electrolytic capacitor
M1—0-1-mA current meter
Q1, Q2—2N4342 (or similar) P-channel junction field-effect transistor (JFET)
R1, R2—1.5-megohm, $\frac{1}{2}$ or $\frac{1}{4}$ -watt resistor

R3, R4—2200-ohm, $\frac{1}{4}$ -watt resistor
R5—680-ohm, $\frac{1}{4}$ -watt resistor
R6—5000-ohm, potentiometer
R7—500-ohm, potentiometer
S1—Single-pole, single-throw (SPST) toggle switch
Misc: Antenna, 6-inch length of # 12 solid-copper (or similar); wire, cabinet, perfboard, wire, hardware, solder, etc.

put of Q1 is connected to the wire pick-up (antenna), while Q2's gate is tied to the circuit's common ground through R2. That type of bridge circuit offers excellent temperature stability; thereby, allowing Q1 to operate in an open-gate configura-

tion. Potentiometer R7 is used to balance the bridge circuit, and R6 sets the maximum meter swing. Capacitors C1 and C2 help to reduce the 60-Hz pickup and adds to the short-term stability of the circuit.

Use a good quality section of perfboard

to mount the parts on, as a porous or damp board material will not work at all for this circuit. The pickup wire can be as long as you want, but if the circuit is to be used in an area where RF or 60 Hz is at a high level, a short pick-up wire of 1 to 6 inches works best. Experiment to find the best circuit sensitivity.

Caution: If you expect to use the circuit more than one time, *do not* let static discharge directly into the circuit's pick-up.

Electronic Stethoscope

A few years ago when the US and Iran were on more friendly terms, our two consultants worked together to solve a major international case for the Shah. The Minister of Wheels and Movement was at his wit's end in trying to locate a *ticking* sound in the Shah's favorite Rolls.

The circuit shown in Fig. 3 is an updated version of the one used by the famous twosome in pin-pointing the tick and saving the day—unfortunately, the quiet and tranquil times did not prevail. A special vibration pickup and an LM324 quad op-amp work together to produce a super-sensitive electronic Stethoscope. Op-amps U1a and U1d of the LM324 are used to better match the impedance of the input and output circuits (U1b and U1c provides gain for the pickup).

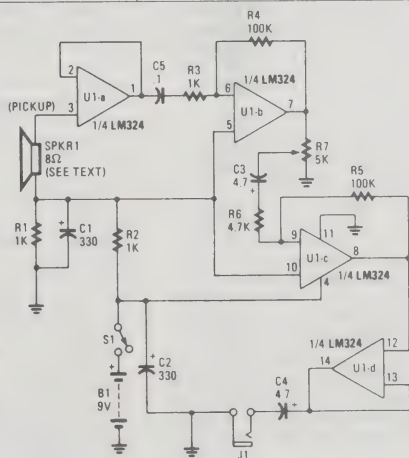
The secret to the success of the circuit is in the construction of the special pickup. A small 1- $\frac{1}{2}$ -inch, 8-ohm speaker, a new penny, and one of mom's sewing needles is all that's required to duplicate our pick-up. Stand the needle up in a perpendicular position on the center of the new penny and solder in place. A word of caution is in order: Watch that needle, it stabs without warning. So be careful.

(Continued on page 27)

PARTS LIST FOR THE ELECTRONIC STETHOSCOPE (FIG. 3)

B1—9-volt transistor radio-type battery
C1, C2—330- μ F, 16-WVDC electrolytic capacitor
C3, C4—4.7- μ F, 16-WVDC electrolytic capacitor
C5—0.1- μ F, mylar capacitor
J1—Normally-open phono jack
R1—R3—1000-ohm $\frac{1}{4}$ -watt resistor
R4, R5—100,000-ohm, $\frac{1}{4}$ -watt resistor
R6—4700-ohm, $\frac{1}{4}$ -watt resistor
R7—5000-ohm potentiometer
S1—Single-pole, single-throw (SPST) toggle switch
SPKR1—1- $\frac{1}{2}$ -inch, 8-ohm mini-speaker modified for vibration pickup only (see text)
U1—LM324 quad op-amp, integrated circuit
Misc: Headphones 2000-ohms or better, cabinet, perfboard, sewing needle, copper penny, wire, solder, etc.

Fig. 3—The Electronic Stethoscope circuit consists of a special vibration pickup (made from a small 8-ohm speaker, a new penny, and one of mom's sewing needles (see text for details), and an LM324 quad op-amp.





CIRCUIT CIRCUS

By Charles D. Rakes

Yesterday's concepts have value in today's electronics

Something old, something new what can circuit number 1 do for you? That's a question you can only answer after reading the following details about this unusual motor-speed control circuit. About 100 years ago, the single-cylinder gas engine began its march through history as a revolutionary source of power that helped to boost our nation into the *high-tech* world of today.

Basically, all gas engines of that time period, and for many years to follow, ran on one of the two following principles of operation. The smoothest method of operation is when the fuel mixture is fed into the combustion chamber in a linear manner. That type is referred to as a *throttle-governor engine*. The throttle-governor engine received a power boost for every complete cycle of operation. Such an engine can be compared to an electronic circuit, operating in a linear fashion.

In the second, and most unusual method—referred to as a *hit-N-miss engine*—the engine's speed is controlled by simply turning on and off the fuel supply as the rpm's vary between high and low set limits. The engine receives a power boost only when the speed drops below a set limit. Under no-load or light-load conditions, it will coast, using no fuel until another boost is needed. The operation of the hit-N-miss gas engine can be compared to an electronic circuit operating in a digital manner.

A correlation between the operation of a gas engine of yesteryear and today's modern AC induction-type motors can be demonstrated by using the hit-N-miss, speed-control circuit in Fig. 1. The 555 timer (U1) operating as a very-low-frequency oscillator (having a rate of less than 1 Hz) supplies drive current to the LED in the optocoupler, U2. The on-time drive current feeding U2 is controlled by R6 and can be set between a low of 10% up to a maximum of 50% on-time. A small 6- to 9-volt DC, wall plug-in supply that's connected to J1 takes care of the circuit's power needs. Triac TR1 (an SC141D 6-amp, 400-volt unit) can operate most small induction motors of 1/4-HP or less. And if needed, a triac with a greater power-handling capacity can be used for TR1.

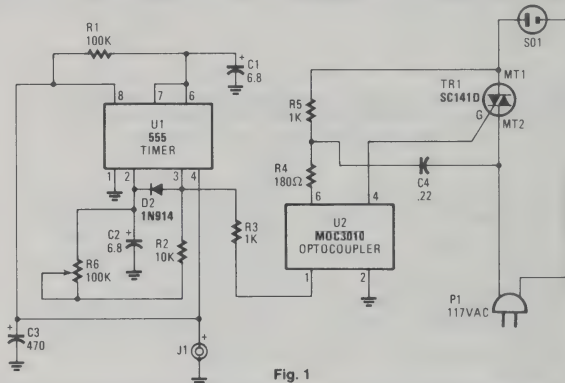


Fig. 1

PARTS LIST FOR THE HIT-N-MISS SPEED CONTROL (FIG. 1)

SEMICONDUCTORS

- D1—1N914, small-signal, silicon diode
- TR1—SC141D 6-A, 400-PIV triac
- U1—555 oscillator/timer, integrated circuit
- U2—MOC3010 optoisolator/coupler

RESISTORS

- R1—100,000-ohm, 1/4-watt, 5%
- R2—10,000-ohm, 1/4-watt, 5%
- R3, R5—1000-ohm, 1/2-watt, 10%
- R4—180-ohm, 1/2-watt, 10%
- R6—100,000-ohm, any-taper potentiometer

CAPACITORS

- C1, C2—6.8- μ F, 25-WVDC, tantalum
- C3—470- μ F, 16-WVDC, electrolytic
- C4—0.22- μ F, 600-WVDC, mylar

ADDITIONAL PARTS AND MATERIALS

- J1—Phono jack for plug-in power supply
- PL1—117-VAC plug with power cord
- SO1—117-VAC receptacle
- Perfboard or printed circuit material, 6- to 9-volt DC plug-in power supply, push-in pins, wire, solder etc.

The speed-control circuit can be assembled on a section of perfboard with push-in pins. (Any suitable layout will do just fine, as the circuit is non-critical.)

A good example of the circuit's operation can be demonstrated by connecting a small circulating fan to J2 and setting R6 for the maximum motor speed. After a short time, the fan's speed will increase until it reaches about 70% of its full rpm rating. At that setting of R6, the fan's motor is being turned on and off at a 50% rate of about .5 Hz. Slowly turn R6 in the opposite direction and note the speed change as the fan's motor is pulsed on and off.

The speed-control circuit works best with small motors that run with a light load, such as our fan. So choose your application carefully and enjoy something new that's based on a 100-year old idea.

Keep in mind that the voltage at SO1 is DC, or to be more precise, rectified AC. If you use a signalling or relay device, it must be rated for DC. For example, a 48-VDC relay would work.

A Flash in the Pan

It's always fun to experiment with electronic LED-flasher circuits; especially if we can make them do something unusual or useful without too much circuitry or

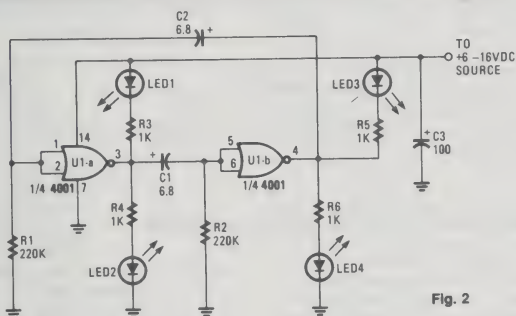


Fig. 2

PARTS LIST FOR THE LED FLASHER (FIG. 2)

C1, C2—6.8-μF, 25-WVDC, tantalum capacitor
C3—100-μF, 25-WVDC, electrolytic capacitor
LED1-LED4—Jumbo light-emitting diode (any color)
R1, R2—220,000-ohm to 1-Megohm ¼-watt, 5% resistor (see text)
R3-R6—1000-ohm, ¼-watt, 5% resistor
U1—4001 quad 2-input nor gate

ADDITIONAL PARTS AND MATERIALS

Perfboard, 6- to 16-volt power source, IC socket, pins, solder, wire, etc.

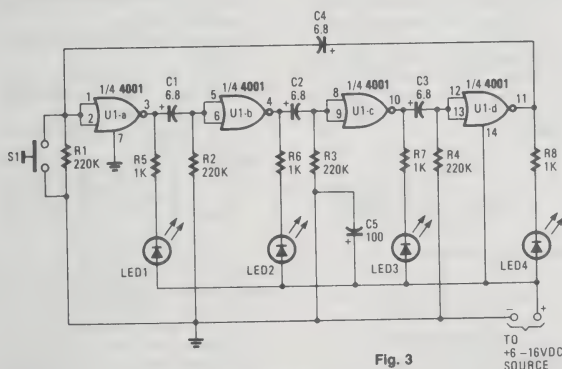


Fig. 3

PARTS LIST FOR THE CMOS QUAD RING-AROUND LED FLASHER (FIG. 3)

C1-C4—6.8-μF, 25-WVDC, tantalum capacitor
C5—100-μF, 25-WVDC, electrolytic capacitor
LED1-LED4—Jumbo light-emitting diode (any color)
R1-R4—220,000-ohm to 1-Megohm, ¼-watt, 5% resistor
R5-R8—1000-ohm ¼-watt, 5% resistor
S1—Normally-open, momentary-contact pushbutton switch
U1—4001 quad 2-input nor gate

ADDITIONAL PARTS AND MATERIALS

Perfboard, IC socket, pins, wire, solder power source, etc.

expense. Our first flasher circuit (see Fig. 2) uses a low-cost CMOS IC to turn the four LED's on and off at a rate that is set by the values of R1, R2, C1, and C2. The pulse rate for the component values given (for R1 and R2) is about one cycle every four seconds. By lowering the values of R1 and R2 to 220K, the pulse rate increases to 1 Hz.

The LED's flash in pairs, with LED1 and LED4 turning on together for one half of the time period, while LED2 and LED3 are on for the other half. The on/off duration of each pair of LED's can be increased or decreased by changing the value of one of the coupling capacitors (C1 or C2). Increasing either capacitor's value by a factor of 10 will also increase the on time of a pair of the LED's for about the same factor. Since we're using inexpensive parts, and there is really no reason for letting half the integrated circuit go to waste, let's use the remaining gates to expand our circuit.

Expanding the Circuit

The first circuit used only two of the gates contained in U1 to flash four LED's

on and off in pairs. But by using the other two gates in a similar circuit, as we've done in Fig. 3, an unusual ring-around, eight-LED flasher circuit can be produced. Although the second circuit is an

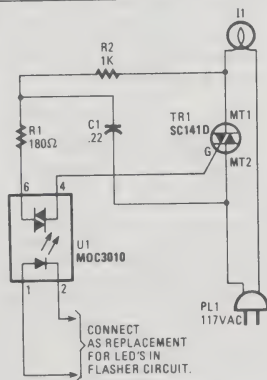


Fig. 4

extension of the first (with inputs and outputs connected in series), the end results are not as we would expect.

When power is first turned on, two of the LED's are on and the other two remain

(Continued on page 30)

PARTS LIST FOR THE BRIGHT LIGHT DRIVER (FIG. 4)

C1—0.22-μF, 600-WVDC, mylar capacitor
I1—100- to 200-watt lamp
R1—180-ohm, ½-watt, 10% resistor
R2—1000-ohm, ½-watt, 10% resistor
TR1—SC141D 6-A, 400-PIV triac
U1—MOC3010 optoisolator/coupler, integrated circuit

ADDITIONAL PARTS AND MATERIALS

Perfboard, 117-VAC power cord with plug, lamp sockets, pins, wire, solder, etc.



By Charles D. Rakes

CIRCUIT CIRCUS

Home-brew projects teach, as well as entertain

THE SIMPLE, UNCOMPLICATED, useful, inexpensive, interesting, and just plain fun. All of those words help to describe this month's collection of circuits, because they're designed for the experimenter who likes to expand, change, modify, and create their own version of a circuit or project.

The heart of the experimental circuits is a home-made two-terminal solid-state component that offers a negative resistance characteristic. So far, that doesn't sound too simple, does it; but once we wade through a minimum of circuit theory, the actual use of the device is true simplicity in itself.

Our home-made, diode-like device can be turned into a voice transmitter, a tone-modulated transmitter, a simple BC (broadcast) receiver, an automatic telephone transmitter, or you can devise your own circuits with a minimum of additional components.

Home-brew Diodes

The schematic diagram in Fig. 1 shows how our two terminal device is constructed from two JFET transistors; an N-channel and a P-channel unit. The JFET pair is interconnected so that only two leads extend out into the real world. Somewhat like a diode, one lead is referred to as the anode (positive terminal) and the other lead the cathode (negative terminal).

Our two-terminal device exhibits a negative resistance characteristic when certain voltages are applied across its leads. That simply means that as the voltage across the device is increased, the current through it is decreased. After the voltage has increased to a level determined by the two JFET's specifications, the current flow through the pair drops to almost zero and remains at near-cut-off until the voltage is increased to the point where one of the JFET's gate junctions breaks down.

At breakdown, the current through the device increases and should be limited by a series resistor. For all of our circuit experimenting, the device is operated well below the breakdown area, but it's an area where additional experimenting can be performed.

Silicon Valley we're not, but building

your own special diode is no problem. Take a pair of complementary JFET transistors and connect them together as shown in Fig. 1. We used Radio Shack's N-channel (276-2035) and P-channel (2N4342) JFET's to make the diode.

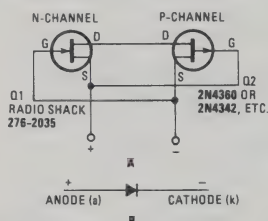


Fig. 1—Home Brew Diode.

PARTS LIST FOR THE HOME-BREW DIODE

- Q1—N-channel JFET, RS #276-2035, ECG 312 or similar
- Q2—P-channel JFET, 2N4360, 2N4342, or similar

Audio Transmitter

The circuit in Fig. 2 might be billed as one of the simplest voice-transmission circuits that can be built. Take an L/C tank circuit, couple it with a mike, add our active two-terminal device, and *bingo* a broadcast transmitter is magically produced. If a tunable loopstick is used for

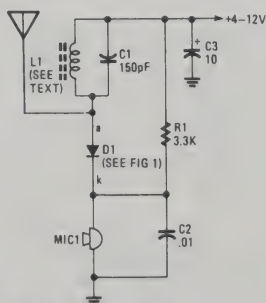


Fig. 2—Audio Transmitter.

PARTS LIST FOR THE AUDIO TRANSMITTER

- C1—150-pF, 100-WVDC ceramic disc capacitor
- C2—.01-μF, 100-WVDC Mylar or similar capacitor
- C3—10-μF, 16-WVDC electrolytic capacitor
- D1—(See text and Fig. 1)
- L1—Tunable loopstick ferrite broadcast antenna coil
- MIC1—Telephone carbon microphone element
- R1—3300-ohm 1/4-watt resistor
- Batteries (or plug-in power supply), pull-up antenna, enclosure, wire, solder, etc.

L1, the transmitter can be tuned to any frequency in the broadcast band; and if the high frequency end of the band cannot be reached, just reduce the value of C1.

Any not-in-use telephone, carbon microphone-element can be used for the transmitter's audio pick-up (MIC1) and any DC power source of 4- to 12-volts at a few milliamps will do for power. A handy method to use in selecting the proper voltage range for the two-terminal device is to build and use the variable voltage-control circuit shown in Fig. 6.

The best operating range for all of the circuits is on the downhill side of the volt-

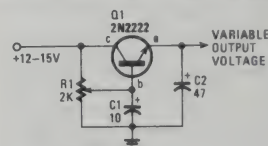


Fig. 6—Variable Power Supply.

age/current negative resistance curve; the exact operating voltage is non-critical, and usually a voltage of 2 to 6-volts will power all of the circuits shown.

Tone-modulated Transmitter

Build the tone-modulated transmitter circuit shown in Fig. 3, and use it as a hidden transmitter for the kids to track down with any portable transistor BC (broadcast) band radio, or use the circuit

FOR THE VARIABLE POWER SUPPLY

C1—10- μ F, 16-WVDC electrolytic capacitor
C2—47- μ F, 16-WVDC electrolytic capacitor
Q1—2N2222A NPN (or similar) transistor
R1—2000-ohm, potentiometer
DC input source of 12 to 15 volts at 25 mA or more
Printed circuit or perfboard materials, wire, solder, etc.

as a wireless code-practice oscillator.

The RF tank circuit (L1/C2) oscillates within the BC band and the combination of C1 and the 1000-ohm winding of T1 makes up an audio tuned circuit that also oscillates at the same time, producing a tone-modulated RF carrier from a single

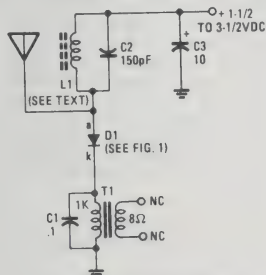


Fig. 3—Tone-modulated Transmitter.

two-terminal active device. The current requirement is so low for the oscillator circuit that a pair of AA cells should power the circuit for days. To change the audio-tone frequency, vary the value of C1, and if a different RF range is desired change the value of L1 and C2 to resonate at the new frequency.

As simple as the basic circuit might seem, you can spend many hours experi-

PARTS LIST FOR THE TONE MODULATED TRANSMITTER

C1—1- μ F, 100-WVDC Mylar capacitor
C2—150-pF, 100-WVDC ceramic disc capacitor
C3—10- μ F, 16-WVDC electrolytic capacitor
D1—(See text and Fig. 1)
L1—Tunable Broadcast ferrite loopstick
T1—1000-ohm to 8-ohm miniature output transformer
Printed-circuit or perfboard materials, batteries or plug in power supply, pull-up antenna, enclosure, wire, solder, etc.

menting with the circuit. You might try replacing L1 and C2 with another transformer like T1 and tune it to another audio frequency and see if a two-tone audio generator can be produced.

BC Receiver

My favorite twin lead circuit is shown in Fig. 4A, which is an ultra simple BC-band, super-regenerative receiver that's capable of picking up a number of local stations, using nothing more than a two foot *hank* of hook-up wire. The incoming radio signal is selected by the tuned circuit made up of L1 and C1, while L2 and C2 form another tank circuit that oscillates and interrupts the oscillation produced by the RF (L1/C1) tuned circuit.

The circuit is a self-quenching type of super-regenerative detector that can offer the experimenter and radio builder an excellent challenge in building and improving the basic circuit. An alternate detector circuit is shown in Fig. 4B. Diode D2 and capacitor C3 are removed from the basic

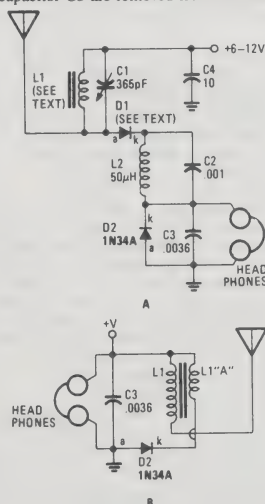


Fig. 4—BC Super-regenerative Receiver.

circuit, and the bottom end of L2 and C2 are connected to ground. A ten turn winding is added to the cold end of L1 (the side that is connected to the positive supply) and connect one end of the coil to the battery positive circuit and the other to the cathode of D2. The headphones and capacitor C3 connect to the circuit as shown in Fig. 4A.

Try each of the detector circuits to determine which one works best for you.

Telephone Transmitter

Build the circuit shown in Fig. 5 and let

PARTS LIST FOR THE BC SUPER-REGENERATIVE RECEIVER

C1—365- μ F, tuning capacitor
C2—0.01- μ F, 100-WVDC Mylar capacitor
C3—0.03- μ F, 100-WVDC Mylar capacitor
C4—10- μ F, 16-WVDC electrolytic capacitor
D1—(See text and Fig. 1)
D2—1N34A Germanium diode
L1—Tunable broadcast ferrite loopstick
L2—50- μ H, inductor
Headphones (2000-ohm), battery (or plug-in power supply), short wire antenna, perfboard, pins, etc.

the kids monitor Grandma's telephone calls on any transistor radio. L1 and C2 set the transmitter's frequency, and the audio present on the phone lines modulates the transmitter's carrier. When the telephone is in the on-hook condition, the voltage applied to the telephone transmitter is nearly 48-volts DC.

Under those circuit conditions, our special (home-brew) diode goes into cut off, drawing almost zero current from the phone circuit. However, when the phone is taken off-hook, the voltage across the phone lines drops to about 4- to 8-volts DC. At that voltage level, the little transmitter automatically turns on to broadcast whatever comes down the phone lines. Need we say more.

That's only a small example of what can be accomplished with a simple home-made two terminal solid-state device. Experiment on your own and see if you can improve those circuits.

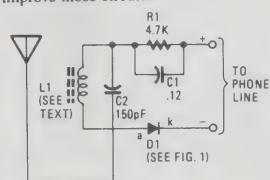


Fig. 5—Telephone Transmitter.

PARTS LIST FOR THE TELEPHONE TRANSMITTER

C1—12- μ F, 100-WVDC Mylar capacitor
C2—150-pF, 100-WVDC ceramic disc capacitor
D1—See Fig. 1 and text
L1—Tunable broadcast ferrite loopstick
R1—4700-ohm 1/4-watt, 5% resistor
Printed-circuit or perfboard materials, small antenna, wire, solder, etc.



By Charles D. Rakes

CIRCUIT CIRCUS

Something different in amplifier circuits

THIS MONTH'S SELECTION OFFERS A hodge-podge of circuits that can keep the most avid experimenter busy and off the streets for hours at a time. The first series of circuits are designed around a simple home-built electro-mechanical device that can amplify or oscillate without the aid of vacuum tube or solid-state device.

Ah! So you thought everything that wiggled electrons had to be one or the other; well it just ain't so. Read on and you will see just how easy it is to build an amplifier or oscillator without using anything discovered or invented after the turn of the century.

Electro-mechanical Amplifier

The first clue to this mysterious amplifying device is shown in Fig. 1. A standard telephone-handset earpiece and carbon-mike element are taped together face-to-face to operate as an electro-mechanical amplifier. A 16-ohm, or higher impedance, horn-type speaker is connected in series with the carbon mike and a battery, as a power source.

When an audio signal is fed to the terminals of the earpiece, it causes the diaphragm contained within the earpiece to vibrate, creating similar variations in air pressure (sound) surrounding the earpiece. The varying air pressure produces a varying current in the mike by shaking the carbon granules to produce an amplified signal current that's fed to the speaker.

Nearly all of today's telephone earpieces have a back-to-back, dual-diode network connected between the terminals to protect the user's ear. That network must be removed to use the earpiece in our amplifier. Before placing the earpiece back into the handset, re-connect the protective network and keep your ears healthy.

PARTS LIST FOR THE ELECTRO-MECHANICAL AMPLIFIER

Battery, 3-6 volt (see text)
Enclosure, wire, solder, hardware, etc.

Horn-type speaker 16-ohm
Single-pole, double-throw switch
Telephone handset earpiece
Telephone handset carbon microphone

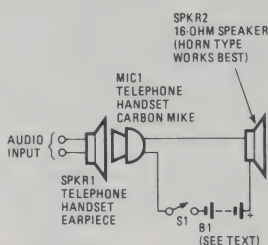


Fig. 1—The Electro-mechanical Amplifier circuit is nothing more than a telephone handset earpiece and carbon microphone element taped together, face-to-face, and series connected to a 16-ohm horn-type speaker and a battery, which powers the circuit.

An ideal power source for all of the amplifier experiments that we'll present this month can be made by connecting 6 to 8 "C" cells in series and tapping at 3, 6, and 9 volts. Those taps will help obtain the best circuit gain and volume output from each of the circuits. Of course if you have a bench DC power supply that can dish out the same voltages at a current of 100 mA or so, use it and spend the battery money on something else.

A good way to check out the basic amplifier, and at the same time familiarize yourself with the device, is to drive the earpiece with the output of a transistor radio or tape player. To best match the impedance of the amplifier to the radio or player's speaker output, use a 500-ohm to 8-ohm mini output transformer between the two units. With the amplifier operating, select the DC voltage that produces the maximum output volume with a minimum of distortion.

If, at anytime, the amplifier's noise level begins to rise, sounding like a giant reptile hissing, turn off the power or lower the operating voltage, as the carbon granules are about to fry. A sharp jar or tap on the mike element can also correct the problem. Just remove the earpiece and you have a handy ultra-simple megaphone circuit that can be a delight to the kids—but you'll probably need earplugs.

Code Practice Oscillator

Now, turning our attention to Fig. 2, we see the world's simplest code practice oscillator circuit. Using next to nothing in the way of components, the circuit consists of a small 2 to 4-inch, 8 or 16-ohm speaker and a carbon mike element. Place the mike face-to-face with the speaker's cone, and presto! A tone generator is born. The frequency of the tone generator can be altered by experimenting with different locations for the mike element on the speaker's cone, and the size and impedance of the speaker used.

The speaker and mike are then series wired, and a battery power source (of 3 to 9 volts) and a single-pole, single-throw switch thrown in to complete that simple series circuit.

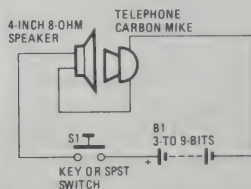


Fig. 2—The Code-Practice Oscillator consists of an 8- or 16-ohm speaker with its cone placed face-to-face with a carbon mike element. The speaker and mike are series wired.

PARTS LIST FOR THE CODE PRACTICE OSCILLATOR

Battery, 3 to 9 volt (refer to Fig. 1 text)
Key or single-pole single-throw switch
Speaker, 8-ohm
Telephone carbon mike

Two-stage Amplifier

The two-stage amplifier shown in Fig. 3A is just as simple as it appears—there are no hidden pitfalls here! And once put together, it can consume several hours of your time experimenting with the basic circuit to obtain its best performance.

The first amplifying stage offers a high input impedance through a single high impedance 1000- or 2000-ohm head-

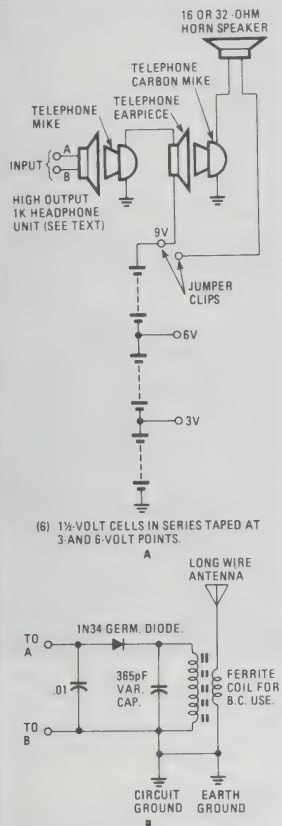


Fig. 3—The first stage of the Two Stage Amplifier (A) offers a high input impedance through a 1000- or 2000-ohm headphone. The second stage is a copy of the amplifier shown in Fig. 1. The circuit shown in B is the schematic diagram of a Crystal radio that can be connected to the Amplifier.

phone for the first mike driver. The second stage is a copy of the single stage amplifier shown in Fig. 1, except that now the carbon mike drives a 16 or 32-ohm horn-type speaker. The tapped battery supply (mentioned in our discussion of Fig. 1) will help in obtaining the best circuit operation and power output from the horn speaker.

If you happen to have a good working crystal radio set in the old junk box, drag it out and connect it to the two-stage amplifier. Then muster up the longest antenna you can and connect it and a good Earth ground to the crystal set. Or if you don't

PARTS LIST FOR THE TWO-STAGE AMPLIFIER

Two telephone carbon microphones
Telephone handset earpiece
Speaker, 16- to 32-ohm
Headphone, 1000-ohm or more
Battery, 3 to 9-volt (see Fig. 1 text)
Crystal radio
D1—1N34 general-purpose germanium diode
C1—0.01- μ F, 100-WVDC ceramic disc capacitor
C2—365-pF, trimmer capacitor
L1—Ferrite broadcast-type coil
Antenna wire, hookup wire enclosure, solder, etc.

have a ready-built detector, you can build the simple crystal radio illustrated in Fig. 3B and connect as shown.

Don't expect the output of the amplified crystal set to rattle the windows or drive everyone outdoors, but under ideal operating conditions a comfortable audio level can be obtained on a strong local station.

The few circuits that we've shown so far only illustrate a limited application of that unusual amplifying device, so get busy and come up with a super design of your own.

Emitter-Coupled Oscillator

If you've ever needed or wanted a simple circuit that would oscillate with about anything resembling a coil, transformer winding, or inductor as the tuned circuit, then wait no longer. The emitter-coupled oscillator shown in Figure 4 is just such a circuit. About the only requirement for

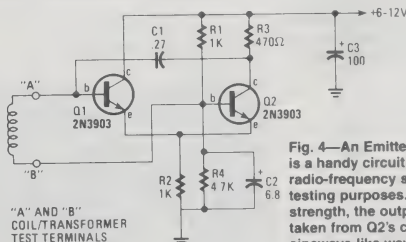


Fig. 4—An Emitter-Coupled Oscillator is a handy circuit when an audio- or radio-frequency signal is needed for testing purposes. For maximum signal strength, the output signal can be taken from Q2's collector; or for a sinewave-like waveform, the signal can be plucked from the base of Q1.

the inductor connected to the circuit is that a DC path must be available through it to supply base bias for transistor Q1.

I even wiped out a station on my FM receiver while playing with the circuit using a clip lead as the tuning inductor. So watch out. In fact, the oscillator circuit is so handy to use in making tests and running experiments when a quick and dirty AF or RF signal is required that I built a permanent test unit just for that purpose.

All parts can be mounted on a small

piece of perfboard and housed in a plastic or metal cabinet. A single 9-volt battery will supply power and an off/on switch (a normally-closed, pushbutton switch is a good choice) will make testing easier. The oscillator's output can be taken off at the collector of Q2 for the maximum signal, but if a sinewave-like waveform is needed, take the signal off at the base of Q1. To obtain a good sinewave, a good L/C tuned circuit is a must. Happy testing.

PARTS LIST FOR THE EMITTER-COUPLED OSCILLATOR

C1—0.27- μ F, 100-WVDC, Mylar capacitor
C2—6.8- μ F, 35-WVDC, electrolytic capacitor
C3—100- μ F, 16-WVDC, electrolytic capacitor
Q1, Q2—2N3903, 2N2222 or similar general-purpose NPN transistor
R1, R2—1000-ohm, $\frac{1}{2}$ -watt, 5% fixed resistor
R3—470-ohm, $\frac{1}{2}$ -watt, 5% fixed resistor
R4—4.7-ohm, $\frac{1}{2}$ -watt, 5% fixed resistor

Semiconductor Tester

The next circuit is designed especially for the experimenter that can not pass up a bargain when it comes to purchasing a bag or box of unmarked semiconductors. Using the test circuit in Fig. 5 can help make the parts purchased a real bargain by allowing you to test parts without damaging them in the process.

To test a semiconductor, simply con-

nect any two leads of the unit to the positive (+) and negative (-) test terminals and monitor the voltage across the device with an external voltmeter. Set S2 for the maximum current flow that you want to allow to pass through the device under test. Diodes are a natural for testing with that circuit—for instance, low-voltage Zeners can be tested and marked as to their voltage with the aid of the circuit. You can determine the polarity of LED's

(Continued on page 28)



Circuit Circus

By Charles D. Rakes

There may be several electronic test instruments lurking in your junkbox

□ THIS MONTH I'D LIKE TO SHARE A FEW handy-dandy test instruments with you that can be put together for a minimum cash outlay (depending on how well stocked your junkbox is) and, for the most part, can't be purchased ready made.

For you experimenters who know Murphy as well as I know Murphy, the time will come when one of those simple circuits could really save the day. For example, not too long ago I had a very distinguished guest who came especially to observe a special project of some importance to my livelihood. And, as fate would have it, one uninvited guest also showed up.

If I had not had the two simple cable-test sets, Murphy would have had me in a most embarrassing predicament. But, as it ended up, I made a good show out of what could have been a very bad and costly one, by using the two cable-test sets shown in Fig. 1 and Fig. 2.

How many times have you had an interconnecting audio, video, or other electronic cable act up and cause a fit when in use, but as soon as you tried to locate the culprit, Murphy smiled, turning it into a do-right operation until the next time you really need it to work perfectly? Sound a little too familiar? If so, duplicate the two following circuits.

Open-Circuit Detector

The circuit in Fig. 1 is designed to check almost any two-conductor cable for open-circuit conditions that usually only show up when the cable is moved about—most often referred to as the intermittent open-circuit cable syndrome. The Open-Circuit Detector uses a single active solid-state device, a low-current silicon-controlled rectifier (SCR) to act as a forget-me-not circuit, that will remember to supply current through the LED as long as the return current path through the cable under test remains complete.

But if the path were to open up for a split second, our circus pachyderm forgets everything and the LED goes out. No matter how many times the connection is re-joined while testing the cable, SCR1 will remain off until the RESET switch is pressed, and if the cable is open at that time it will not reset.

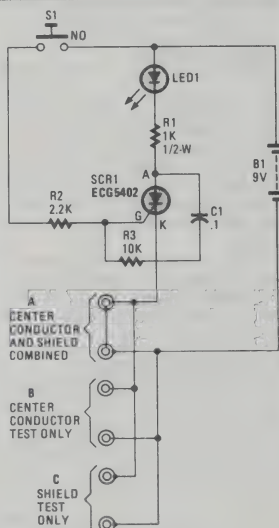


Fig. 1—Open-Circuit Detector

If you build the circuit in a plastic case, you will not need to isolate each of the test sockets—making the construction job a whiz. The test-socket arrangement shown at point "A" in the schematic diagram checks both the shield and center conductor of the same cable simultaneously by routing the two leads in series through the test sockets. If a metal cabinet is used, those two transistor test sockets will need to be isolated from the cabinet to operate properly.

If an open circuit slows up while using the "A" test sockets and you want to determine if the open is in the shield or the center conductor, move on to the "B" test socket and test the cable for an open center conductor. Nothing there? Go on to the "C" sockets, and check out the shield. Even with all of Murphy's laws working overtime, you should be able to locate the cable's defect in short order and make repairs when possible.

PARTS LIST FOR THE OPEN-CIRCUIT DETECTOR

B1—Battery, 9-volt type
C1—0.1- μ F, ceramic disc capacitor
LED1—Jumbo red light-emitting diode
R1—1000-ohm, 1/2-watt, 5% resistor
R2—2200-ohm, 1/2-watt, 5% resistor
R3—10,000-ohm, 1/2-watt, 5% resistor
SCR1—ECG5402, 8-A, 100-PIV, silicon-controlled rectifier
S1—Normally open, momentary contact, pushbutton switch
Printed-circuit or perfboard materials, battery holder and snap-on connector, jack, (RCA, F-type, BNC, etc.), enclosure, wire, solder, hardware, etc.

You can use any number, and combination of connectors for testing audio cables, RF cables, or any other two-conductor cables, and they can be wired in three's for shielded or a single pair will do for non-shielded.

Short-Circuit Detector

If an intermittent-open cable isn't enough for Mr. Murphy, he will introduce you to that infamous *will-o'-the-wisp* short circuit that can come and go at will. Never fear, 'cause we've got Murphy covered on this one too. The ultra-simple circuit in Fig. 2 will ferret out any shorted two-wire cable in a New York minute with

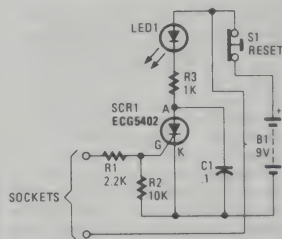


Fig. 2—Short-Circuit Detector

B1—Battery, 9-volt type
C1—0.1- μ F, ceramic disc capacitor
LED1—Jumbo red light-emitting diode

R2—10 000-ohm, 1/2-watt, 5% resistor

Printed-circuit or perfboard materials, battery holder and snap-on connector, jack, (RCA, F-type, BNC, etc.), enclosure, wire, solder, hardware, etc.

If a very-long shielded cable is connected to the circuit and the LED lights instantly, it might not indicate a short in the cable, but could be caused by the cable's internal capacitance charging up through the gate-cathode junction of the SCR and turning it on. If that proves to be a permanent problem, a .047μF, 100-WVDC mylar capacitor can be connected between the SCR's gate and cathode, but for short cables, that correction should not be needed.

Here again, you can connect as many pairs of RF, audio, etc., types of connectors to the test circuit as needed. But, since they should all be isolated from each other, a housing of plastic would be ideal for this circuit as well.

The circuit in Fig. 3 is a handy tester for checking a large number of semiconductor devices that may have been either scrounged from the bottom of our junkbox or purchased at the bargain counter. Many are *orphaned* parts without a family tree to hang on to. The majority of our two- and three-legged solid-state friends can be checked simply by connecting them to the test-circuit terminals, and operating a couple of switches.

The operation of the test circuit goes something like this; a PNP or NPN transistor is connected to the test terminals, while one of the push-button switches (S1-S3) is pressed. If one of the LED's light, look at the polarity reversal switch S4 and see if it's in the PNP or NPN

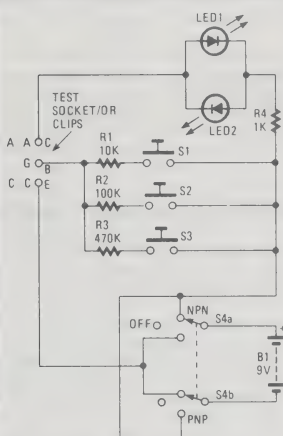


Fig. 3—Semiconductor Tester

position. If both LED's fail to light, reverse the position of R4; if the device is OK, an LED will light. After you have the LED glowing, let up on the push-button switch and the glow should go out. If not, the device is most likely shorted. Naturally all of the three-legged devices must be connected correctly to the test terminals to check out properly, but since the circuit is user friendly and non-destructive, try all combinations to determine the type and condition of the device at the same time.

Low- and medium-current SCR's can be checked with the circuit. Plus, you can get a feel for the gate-current sensitivity

LED1, LED2—Jumbo red light-emitting diode

R2—100,000-ohm, 1/4-watt, 5% resistor

R3—470,000-ohm, 1/4-watt, 5% resistor

R4—1000-ohm, ¼-watt, 5% resistor
S1, S3—Normally-open momentary switch

S1-S3—Normally-open, non-contact, pushbutton switch.

S4—Double-pole, 3-position rotary switch

Printed-circuit or perfboard materials, 9-volt transistor battery and snap-on connector, jack, lead, enclosure, wire, solder, wire, etc.

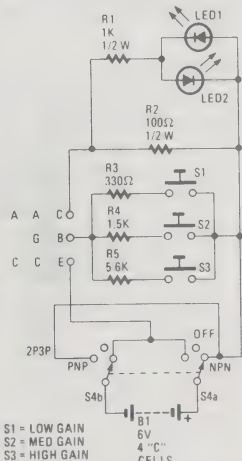


Fig. 4—High-power Semiconductor Tester

If you've ever needed an expanded voltmeter (but couldn't see paying the price), try the ultra-simple and cheap approach shown in Fig. 5. The complete circuit contains only three parts plus your favorite VOM, and even if your junkbox is empty the cost will be less than five bucks.

The circuit can be set up to suppress
(Continued on page 29)



By Charles D. Rakes

Circuit Circus

Analyze voice-scrambling techniques using two simple circuits

□ IN THIS MONTH'S "CIRCUS OF Circuits," we're going to explore the altered state of voice communication, or how to foul up speech so that no one can tell who's speaking, without destroying the contents of the message. You can have fun with your friends when you use one of the circuits to disguise your voice by making it sound higher or lower in pitch. And by adding another circuit (a very low frequency amplitude modulator), you can add a tremolo effect.

The circuits can be used singularly or in tandem, and the modified speech can be coupled to the telephone line for extra fun. Just think what the circuits can do for next year's Halloween party. But enough of the verbal prelude; let's get to the real heart of the matter.

Voice Scrambler

I'm sure you've seen and heard those national news telecasts, wherein a secret government witness, speaking with a

spaced-out high or low-pitched voice, tells all. Well a similar effect can be obtained with the circuit shown in Fig. 1.

That circuit uses two interconnected, balanced-diode mixers to obtain the dual-frequency shift that's necessary to add special effects to any audio that is coupled to the circuit's input. If we cut the circuit in half at the output of transformer T2, and include the U1a tone-oscillator circuit, we have a single mode inversion circuit that shifts the frequency of all input signals to a new higher- and lower-output frequency. The actual amount of frequency shift is determined by the frequency of the carrier oscillator (U1a) circuitry.

With a carrier frequency of 3.5 kHz, and a 2.5-kHz input tone, two new frequencies appear at the output of T2: the sum frequency set at 6 kHz, and the difference frequency at 1 kHz. The difference frequency is the one that we'll use to mix with the second single-mode inversion circuit to produce the desired effect.

The sound of your voice at the output of the single-inversion circuit would definitely be disguised to a point that no one could recognize it but neither would anyone be able to understand anything you said. That's because all of the low-voice tones would be shifted to higher frequencies, and all of the high-voice tones would be shifted to lower-frequency sounds. The same basic single-mode inversion circuit is used on a daily basis across the country by many police departments, as a voice-scrambling system.

The audio heard from a receiver without a descrambler sounds somewhat like an off-tuned single side-band signal on a communication receiver, or Donald Duck with a bad cold.

If the audio from the single-inversion circuit is fed into a second such circuit, operating with a carrier oscillator on the same frequency as the first, the output sounds normal. And here's why: The 2.5-kHz input tone came out of the first inver-

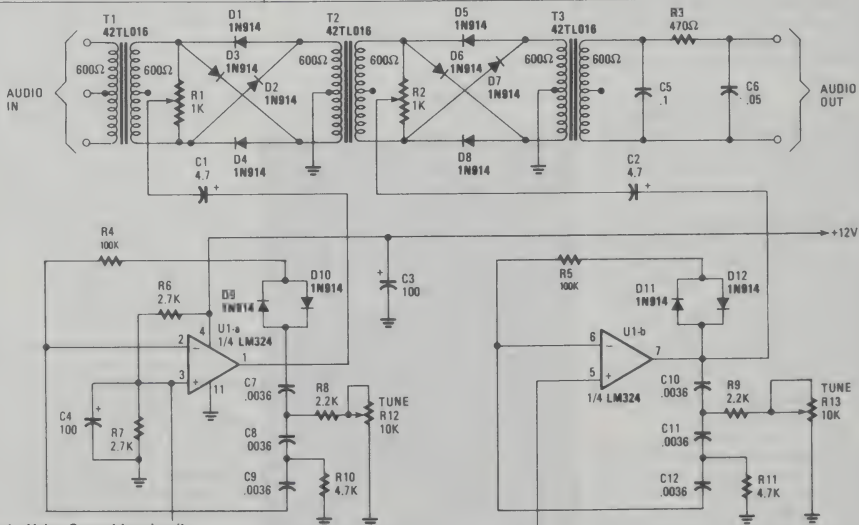


Fig. 1—Voice-Scrambler circuit

sion stage at a new difference-frequency of 1 kHz. The 1-kHz signal is fed into the second stage. The difference-frequency at the output of the second stage is 2.5 kHz. (3.5 kHz minus 1 kHz brings us back to the original 2.5 kHz).

Why, you might ask, go through all of that trouble to get back to where you started from in the first place? The point is that we don't want to get back to the *exact* starting place, but instead to be off enough in the frequency of the second carrier oscillator to produce a voice output sound that's either a few cycles higher or lower than your normal voice. When the second carrier oscillator is tuned to 3.6 kHz (or 100 Hz higher than the first carrier oscillator), the frequency of the voice output will also be shifted 100 Hz higher.

If you have a frequency counter, use it to make a rough calibrated dial for each of the carrier oscillators. That helps in repeating a given sound effect. Since the circuit is intended for experimental use, and subject to a number of modifications, perfboard construction would be a good way to go. The 1N914 silicon diodes used in the two inversion circuits can be matched for their *forward-on-resistance* by using almost any VOM.

By matching the four diodes in each of the circuits, the mixing of the voice sig-

nals and the balancing of the carriers will be much easier to accomplish.

Two op-amps, from an LM324 quad op-amp chip, are used as the active devices for the two-phase, shift-carrier oscillators, with each output feeding its own mixer circuit. Both oscillators can be tuned above 3.5 kHz and below 2 kHz, and produce a near-sinewave output. If either of the oscillator circuits refuse to wiggle an output, try raising the amplifier's gain by increasing the value of R4 or R5 until the circuit takes off.

A quick check to see that both op-amps are properly biased is to measure the voltage at pin 1 and pin 7. Both should measure about 6-volts.

To set up and check out the altered-state circuit, tune each of the carrier oscillators to about 3.5 kHz, and set the two balancing potentiometers, R1 and R2, to mid range. Connect a high impedance set of headphones, or an audio amplifier with a speaker output, to the audio output of the circuit. Locate a talk show or newscast on a local radio station, or a pre-recorded tape on a cassette recorder, and patch the audio to the input of the circuit.

With the audio circuit connected, but with no audio coming out (volume turned

down), listen to the output and adjust both R1 and R2 for a minimum tonal output. That's the fine adjustment for both of the carrier balancing potentiometers. Bring the volume up until a suitable listening level is obtained and play with the setting of R13 to obtain the desired sound effect.

Let's Go Tremolo

The tremolo circuit in Fig. 2 can be fabricated on the same piece of perfboard to share the unused op-amps of U1 and the power source. The tremolo circuit can be connected to the output of the frequency shift circuit in Fig. 1 to add another dimension of change to the audio sound.

The tremolo circuit adds an amplitude modulation effect, at a sub-audible rate, to the audio as it passes through, giving it a wavering effect. Operation is very simple and goes like this: U1c is connected as an inverting amplifier, with a gain of less than 2. A portion of the gain-setting feedback resistor R3 is connected in parallel with an N-channel TMOS FET transistor identified as (Q1).

The FET, operating like a variable resistor, is driven by the output of the VLF phase-shift oscillator to cause the ampli-

(Continued on page 30)

PARTS LIST FOR THE VOICE SCRAMBLER

CAPACITORS

C1, C2—4.7- μ F, 25-WVDC, electrolytic
C3, C4—100- μ F, 16-WVDC electrolytic
C5—.1- μ F, 100-WVDC Mylar
C6—.05- μ F, 100-WVDC Mylar
C7—C12—.0036- μ F, 100-WVDC Mylar

RESISTORS

(All resistors are 1/4-watt, 5% fixed units unless otherwise noted.)
R1, R2—1000-ohm potentiometer
R3—470-ohm
R4, R5—100,000-ohm
R6, R7—2700-ohm
R8, R9—2200-ohm
R10, R11—4700-ohm
R12, R13—10,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS

D1—D12—1N914 silicon diodes
T1—T3—600-ohm to 600-ohm center-tapped audio transformer (Mouser part No. 42TL016, or similar)
U1—LM324 quad op-amp, integrated circuit
Perfboard or printed circuit material, IC socket, pins, etc.

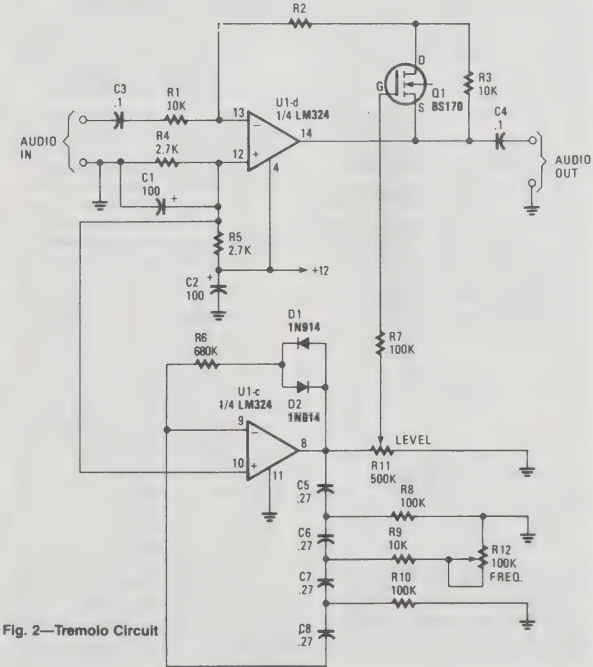


Fig. 2—Tremolo Circuit



Circuit Circus

By Charles D. Rakes

If you've been searching for just the right touch switch, look no further....one of these is sure to suit your application

□ EACH OF THE CIRCUITS OFFERED IN THIS month's Circus are a part of the electronic petting zoo. In other words, each of the circuits have been designed to respond to a warm touch by a human hand. The electronic touch switch is a novel and handy gadget that eliminates many of the problems associated with standard mechanically-operated switches.

If you have ever flipped a toggle switch and had the bat remain in your hand as the innards tinkled to the bottom of the cabinet, you can appreciate the confidence conferred by using a touch-type switch.

Touch On-only Switch

The Touch On-only Switch shown in Fig. 1 can trigger into conduction by electrical means and can only be reset through a mechanical switch, but for some circuit applications, it's ideal. For example, in a simple alarm circuit, the turn-on only switch is just what the doctor ordered, because we want the burglar to trigger the

alarm, and under no circumstances be able to turn it off.

When your finger meets the circuit's touch contact, a 60-Hz signal is delivered to the gate of the SCR, turning it on. Since the majority of the single-contact, touch-switch circuits feed on the stray 60-Hz AC field from the surrounding area, they should be powered with an AC-derived, DC power-supply.

A new copper penny makes an excellent low-cost touch contact for the circuit's pick-up terminal, but a 1-inch square piece of circuit-board material does as well. The component values are not critical and can vary some; but for a sensitive switch, SCR1 should be one that's triggered by a very-low gate current.

PARTS LIST FOR THE TOUCH ON/OFF SWITCH

- C1—.27- μ F/100-volt mylar capacitor
- LED1, LED2—Light-emitting diode (any color)
- SCR1, SCR2—2N5062 (or similar)
- .8-A, 100-PIV silicon-controlled rectifier
- R1, R2—470-ohm, $\frac{1}{2}$, 5% resistor
- R3, R4—1-Megohm, $\frac{1}{2}$, 5% resistor
- R5, R6—1000-ohm, $\frac{1}{2}$, 5% resistor

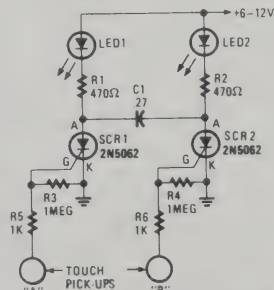


Fig. 2—The Touch On/Off Switch is built around two SCR's that are interconnected, such that when one is turned on, the other (if on) is forced off, either LED1 or LED2, depending on which terminal is touched.

Touch On/Off Switch

If a Touch On/Off Switch is desired, the circuit in Fig. 2 fills the bill. Two sensitive gate SCR's are interconnected, so that when one of the devices is turned on, the other (if on) is forced off. That toggling effect gives an on/off circuit condition for each of the LED's in the SCR-anode circuits. To turn LED1 on and LED2 off, simply touch the "A" terminal, and to turn LED1 off and LED2 on, the "B" pick-up must be touched. It is possible to simultaneously touch both terminals, causing both SCR's to turn on together. To reset the circuit to the normal one-on/one-off condition, momentarily interrupt the circuit's DC power source.

Additional circuitry can be connected to the anode circuit of either or both SCR's to be controlled by the on/off function of the touch switch.

PARTS LIST FOR THE DIGITAL TOUCH SWITCH

- LED1, LED2—Light-emitting diode (any color)
- R1, R2—470-ohm, $\frac{1}{2}$, 5% resistor
- R3, R4—10-Megohm, $\frac{1}{2}$, 5% resistor
- U1—4001 quad two-input nor gate

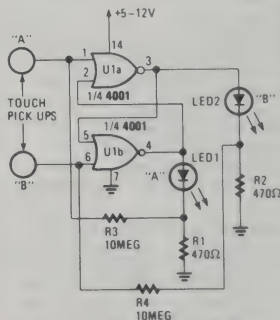


Fig. 3—The Digital Touch On/Off Switch, built around a 4001 CMOS quad two-input nor gate configured as an anti-bounce latching circuit, allows only one LED to be on at a time.

PARTS LIST FOR THE TIME-ON TOUCH SWITCH

BZ1—Piezoelectric buzzer
C1—10- μ F 16-WVDC electrolytic capacitor
LED1—Light-emitting diode (any color)
R1—10-Megohm, $\frac{1}{2}$, 5% resistor
R2—100,000-ohm, $\frac{1}{2}$, 5% resistor
R3—1000-ohm, $\frac{1}{2}$, 5% resistor
U1—555 oscillator/timer, integrated circuit

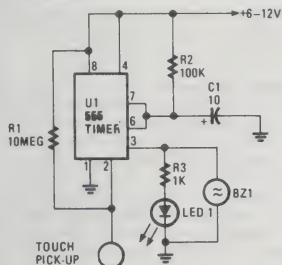


Fig. 4—The Time-on Touch Switch, built around a 555 oscillator/timer (U1), is turned on when a trigger is applied—by touching the touch terminal—to pin 2 of U1. When activated, LED1 and BZ1 (a Piezoelectric buzzer) turn on for the time period set by the value of R2/C1.

Digital Touch On/Off Switch

Another on/off Touch Switch circuit, built around a digital IC, is shown in Fig. 3, which offers an advantage in some circuit applications that the previous circuit(s) can not master. Only one LED can be on at a time when the circuit is at rest. Which LED is illuminated is determined by the touch pick-up that last had human contact.

Pickup terminal "A" controls the on condition of LED1, and terminal "B" controls the on condition of LED2. A 4001 quad two-input NOR gate is connected in an anti-bounce latching circuit that is activated by touching a pickup.

Time-on Touch Switch

The Time-on Touch Switch circuit shown in Fig. 4 is built around a 555 oscillator (U1), which is turned on when a trigger is applied—by touching the touch terminal—to pin 2 of U1. When activated, LED1 and BZ1 (a piezoelectric buzzer) turns on for the time period set by the values of R2 and C1. The on-time of the touch circuit can be altered by changing the values of C1 and R2.

The Time-on Touch Switch can be powered from batteries, so that it need not be near a 60-Hz power source for triggering. The extremely small amount of current supplied to the trigger input through

PARTS LIST FOR THE TWO-TERMINAL TOUCH SWITCH

C1—680-pF, 600-WVDC ceramic disc capacitor (see text)
LED1—Light-emitting diode (any color)
Q1—2N5089 high-gain NPN silicon transistor
Q2—2N3904 general-purpose NPN silicon transistor
Q3—2N3906 general-purpose PNP silicon transistor
R1—15,000-ohm, $\frac{1}{2}$, 5% resistor
R2—10,000-ohm, $\frac{1}{2}$, 5% resistor
R3—4700-ohm, $\frac{1}{2}$, 5% resistor
R4—470-ohm, $\frac{1}{2}$, 5% resistor

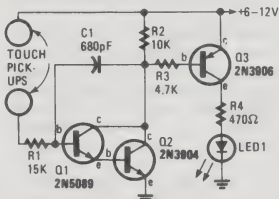


Fig. 5—The Two-Terminal Touch Switch requires the bridging of two circuits for activation. Built around a Darlington amplifier, the circuit multiplies the small bridging current to a value of sufficient magnitude to turn on Q3, supplying power to LED1.

the 10-megohm resistor, R1, makes the input circuitry very sensitive to any external loading, and it is easily triggered by touching the pickup.

Two-terminal Touch Switch

The Two-Terminal Touch Switch shown in Fig. 5 requires the bridging of two circuits to activate the electronic switch. That circuit does not require a 60-Hz field to operate and can be battery or AC powered. The two pickup terminals can be made from most any clean metal, and should be about the size of a penny.

The input circuitry of the Two-terminal Touch Switch is a high-gain Darlington amplifier that multiplies the small bridging current to a value of sufficient magnitude to turn on Q3, supplying power to LED1. If a quick on and off switching time is desired, the value of C1 should be very small, but if a long on-timed period is required, the value of C1 can be increased. For a short on-time, the value of C1 should be 680-pF; for a 7-second on-time try a .039-microfarad unit, and to increase the on-time to a full 50-seconds, use a .27-microfarad capacitor.

Temperature-dependent Touch Switch

Unlike the previous circuits, the one in

PARTS LIST FOR THE TEMPERATURE-DEPENDENT TOUCH SWITCH

D1, D2—1N914 silicon signal diode
LED1—Light-emitting diode (any color)
R1—1000-ohm, $\frac{1}{2}$, 5% resistor
R2, R3—2200-ohm, $\frac{1}{2}$, 5% resistor
R4—470-ohm, $\frac{1}{2}$, 5% resistor
R5—1000-ohm, $\frac{1}{2}$, 5% potentiometer (any taper)
U1—LM324 quad op-amp, integrated circuit

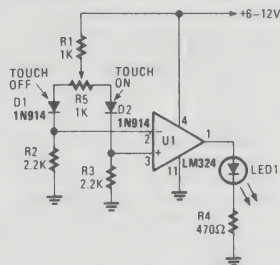


Fig. 6—The Temperature-Dependent Touch Switch, unlike the previous circuits, requires neither a 60 Hz field nor a current flow into or out of the touch pickup to cause the switch to operate.

Fig. 6 requires neither a 60-Hz field or a current flow into or out of the touch pickup to cause the switch to operate. Take a look at the circuit and see if you can figure it out. Give up?

First, notice that U1 (an LM324 quad op-amp) is connected in a comparator circuit that's used to monitor the voltage drop across two resistors (of the same value) in a resistor/diode bridge circuit.

With R5 adjusted to supply a slightly larger current flow through R2, U1 sees a higher voltage at it's non-inverting (–) input terminal (pin 2), causing its output at pin 1 to be at or near ground potential. Thus, the LED will be dark. But if we can somehow cause the voltage at pin 3 of U1 to go more positive than the voltage at pin 2, the output toggles from zero to a +V, lighting LED1. No...Adjusting R5 isn't the answer.

The circuit is turned on by touching diode D2 with a warm finger. If U1 sees a adjusted properly, LED1 will turn on. Remove the finger and LED1 goes out. The secret ingredient, as you've probably guessed, is the "warm" digit (finger) that made contact with the temperature sensitive silicon diode, D2.

As the diode is heated slightly by body warmth, the current through it increases, causing the voltage across R3 to rise slightly. That increased current causes a flip-flop within the op-amp to respond by

(Continued on page 27)



CIRCUIT CIRCUS

By Charles D. Rakes

Don't change power supplies—produce what you need from what you have!

THE CIRCUIT THIS MONTH STARTS OFF with a circuit that goes from positive to negative in a flash, without the aid of that long standing nemesis, Mr. Murphy, and ends up being a working and useful circuit that could fit in your next project.

DC Voltage Inverter/Doubler

The DC Voltage Inverter/Doubler circuit shown in Fig. 1 turns a 12- to 15-volt positive-power source upside down, creating a variable-regulated negative supply. The negative output voltage can be set to any voltage level between 1 and 10-volts when the circuit is operated from a 15-volt power source, and can supply up to 20 mA of operating current to a connected load.

A 555 oscillator/timer, operating as a free running astable oscillator, feeds its output at pin 3 to a voltage-doubler circuit that is connected for a negative output. Without the unusual feedback circuit (components R4 and R5) the DC Inverter will produce a negative output voltage

that's about 80% of the positive-power source. The regulator circuit operates best with a load; and when a regulated power source is used, the load/no-load output voltage will only vary a few millivolts.

Voltage Doubler

Have you ever had a favorite circuit or project that you wanted to use in your automobile; but, as fate would have it, a part of the circuit required a slightly higher voltage than the 12-volts offered by the car's battery? If so, take a look at the DC converter circuit in Fig. 2.

A 555 oscillator/timer, configured similarly to the one in Fig. 1, feeds a positive voltage-doubler circuit that produces the higher DC output voltage. Transistors Q1, Q2, and diode D3 add regulation and a variable output function to the circuit. If the regulator circuit is removed and a 12-volt supply is applied directly to the oscillator circuit (top of C1), the output will be over 25 volts and will vary in level with supply voltage changes and load varia-

tions. An output current of over 30 mA can be supplied at a regulated output of 6 to 16 volts.

Voltage Multiplier

The DC Voltage Multiplier circuit might just tickle your funny bone if you let your fingers do the walking through the circuit—while the power is on—as it steps up the 12-volt supply to over 117-volts. Although the output voltage stands tall, the circuit has very little *umph* in the output-current department; and even a light load drawing, say, 1 mA will drop the output voltage to about half.

The Voltage Multiplier can be used to supply a bias voltage to a high-impedance circuit, to ignite neon lamps, for testing the reverse-breakdown voltage of semiconductors, or for any other application where a high-voltage, low-current power supply is required.

Figure 3 shows the complete high-voltage circuit. Old reliable—the 555 oscillator/timer—is used to generate the switching voltage (AC to those in the know) that feeds the primary of T1. The AC voltage is stepped up by transformer T1 and rectified in a two-diode, voltage-doubler circuit to produce the 117-volts DC at the output. The simplest way to make the output variable is to adjust the input voltage supplying power to the converter circuit to obtain the desired output.

No I don't, unfortunately, own stock in any of the companies that produce the versatile 555, and I didn't start out this month's Circus to feature an old friend in each of the circuits, but experimenting with the device is too much fun to stop now, so here's another 555 circuit.

Electronic Wake-up Call

The first three circuits using the 555 were of the serious type designed to work with, or in, another circuit or project; but the Wake Up circuit is for fun only. A real tomfoolery circuit if ever there was one. No serious stuff with this one folks, so dig in and have a ball.

The Electronic Wake-up Call circuit shown in Fig. 4 is designed to help you get moving when sleeping is at its best. Now if you are against having a solar-activated squawk box telling you when it's time to

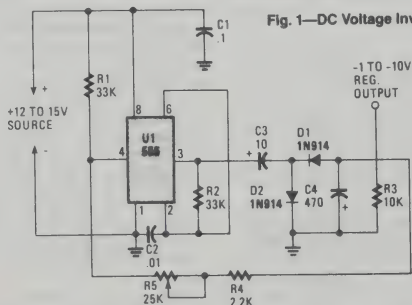


Fig. 1—DC Voltage Inverter/Doubler

- C1—1-μF, 100-WVDC, Mylar capacitor
- C2—.01-μF, 100-WVDC, Mylar capacitor
- C3—10-μF, 25-WVDC, Electrolytic capacitor
- C4—470-μF, 25-WVDC, Electrolytic capacitor
- D1, D2—1N914 general-purpose silicon diode
- R1, R2—33,000-ohm, ½-watt, 5% resistor

- R3—10,000-ohm, ½-watt, 5% resistor
 - R4—2200-ohm, ½-watt, 5% resistor
 - R5—25,000-ohm potentiometer
 - U1—555 oscillator/timer, integrated circuit
- Printed-circuit or perfboard materials, etching solution, power supply or battery, enclosure, wire solder, hardware, etc.

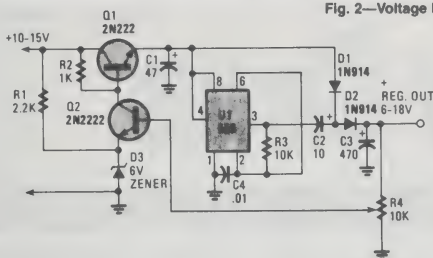


Fig. 2—Voltage Doubler

C1—47- μ F, 25-WVDC, Electrolytic capacitor
C2—10- μ F, 35-WVDC, Electrolytic capacitor
C3—470- μ F, 35-WVDC, Electrolytic capacitor
C4—.01- μ F, 100-WVDC, Mylar capacitor
D1, D2—1N914 silicon signal diode
D3—5 or 6-volt, Zener diode
U1—555 oscillator/timer, integrated circuit

Q1, Q2—2N2222 NPN general-purpose transistor
R1—2200-ohm, $\frac{1}{2}$ -watt, 5% resistor
R2—1000-ohm, $\frac{1}{2}$ -watt, 5% resistor
R3—10,000-ohm, $\frac{1}{2}$ -watt, 5% resistor
R4—10,000-ohm, potentiometer
Printed-circuit or perfboard materials, etching solution, power supply or battery, enclosure, wire solder, hardware, etc.

get up, then casually leave it at a friend's house and let him enjoy the benefits of early rising to meet the break of day. A cloudy day might foul up the circuit, but then nobody's perfect anyway. Don't despair, if the Sun *don't* shine where you at, because you can still make friends with the Electronic Wake-Up Call circuit by hiding it in a closet, or in a desk, or file cabinet, or? And when the light wakes the circuit up, you will have made another

good buddy. Get the picture?

The operation of the Wake-Up circuit in Fig. 4 goes like this. A cadmium sulfide photocell (LDR1), which is a light-dependent resistor) is connected to the base and collector of an NPN transistor, Q1. When light hits LD1, the internal resistance goes from a very high (dark) value to a low (light) value, supplying base current to Q1, turning it on.

The voltage across R1 produces a bias

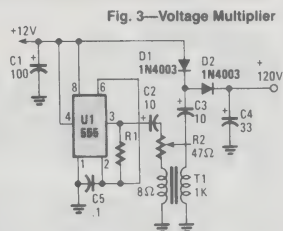


Fig. 3—Voltage Multiplier

C1—100- μ F, 25-WVDC, Electrolytic capacitor
C2, C3—10- μ F, 250-WVDC, Electrolytic capacitor
C4—33- μ F, 250-WVDC, Electrolytic capacitor
C5—.01- μ F, 100-WVDC, Mylar capacitor
D1, D2—1N4003 1-A, 200-PIV rectifier diode
U1—555 oscillator/timer, integrated circuit
R1—10,000-ohm, $\frac{1}{2}$ -watt, 5% resistor
R2—475-ohm, $\frac{1}{2}$ -watt, 5% resistor
R3—1K-ohm, $\frac{1}{2}$ -watt, 5% resistor
T1—Miniature 8-ohm to 1K audio transformer
Printed-circuit or perfboard materials, etching solution, power supply or battery, enclosure, wire solder, hardware, etc.

that turns Q2 on, which in turn, supplies the positive voltage to U1 at pin 8 (the positive-supply input) and pin 4 (the reset input), to operate the 555 audio oscillator circuit. The circuit's sensitivity to light can be set via R6 (a 50,000-ohm potentiometer). R7 sets the audio tone to the most undesirable sound. The squarewave audio tone is fed from U1 pin 3 to a small speaker through coupling capacitor C4 and current limiting resistor R4.

The complete circuit can be built in a light, plastic cabinet with LDR1 facing out through a small hole that will only let light in from a single direction. Other than that, build and use the Wake-Up circuit anyway you please. And until next month help a friend wake up on time. ■

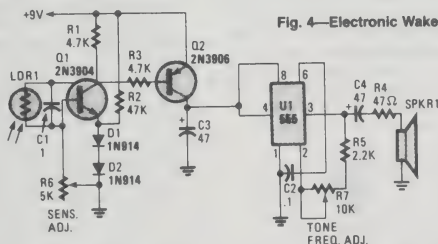


Fig. 4—Electronic Wake-Up Call

C1, C2—.1- μ F, 100-WVDC, Mylar capacitor
C3, C4—47- μ F, 16-WVDC, Electrolytic capacitor
D1, D2—1N914 silicon signal diodes
LDR1—Light-dependent resistor
U1—555 oscillator/timer, integrated circuit
Q1—2N3904 NPN general-purpose transistor
Q2—2N3906 PNP general-purpose transistor
R1, R3—4700 ohm $\frac{1}{2}$ -watt, 5% resistor

R2—47,000-ohm, $\frac{1}{2}$ -watt, 5% resistor
R4—47-ohm, $\frac{1}{2}$ -watt, 5% resistor
R5—2200-ohm, $\frac{1}{2}$ -watt, 5% resistor
R6—50,000-ohm potentiometer
R7—10,000-ohm potentiometer
SPKR1—Small 8 or 16-ohm speaker
Printed-circuit or perfboard materials, etching solution, power supply or battery, enclosure, wire solder, hardware, etc.



NEILSON
"Everytime you dial your mother's phone number you erase last month's inventory!"



CIRCUIT CIRCUS

By Charles D. Rakes

□GETTING THE CIRCUITS WORKED OUT and ready for this month's circus has been a real ball for me, as I have always wanted to put together a few special circuits designed to increase and expand the use of the plentiful and popular portable cassette tape recorder, and best of all be able to share the experience with others. In fact, you can thank one of our fine Circus readers for suggesting a need for a gadget that became our first circuit offered this month.

Extended-Play Circuit

If, more often than not, you tend to come up just a few feet short of having enough tape to complete a recording, then our time-expander circuit (see Fig. 1) should help solve that problem. No, I'm not suggesting taking the tape and stretching it out to increase the recording time, but instead to slow down the rate of tape travel and double, or perhaps even triple, the recording time of your cassette recorder. Sounds difficult? Not at all if you have a recorder you are willing to get into and make a minor modification that will in no way effect the normal operation of the machine.

The trick is to slow the DC-powered, tape-drive motor down without causing it to stall or vary greatly in speed. No, a pot in series, or a reduction in the motor's

supply voltage just won't do. To try either of those simple methods, most assuredly, will end in failure with the motor either stalling or wobbling up and down in speed.

If we can keep the motor's supply voltage at its normal preset value and somehow vary the time that the voltage is applied to the motor, the speed will be reduced and should be fairly constant. The on/off timing interval can not be too slow or the motor will slow when no power is applied and speed up when the voltage is turned on. But if the on/off rate is just fast enough, say about 200 Hz, the motor will not be able to respond in a stop and start operation, and will run smoothly at a slower than normal speed.

A single op-amp (one of four contained in the popular LM324) is operating in a variable pulsewidth, free-running square-wave oscillator circuit, with its timed output driving two transistors that control the on/off cycle of the tape-drive motor.

The oscillator's positive feedback path holds the secret to the successful operation of the variable on/off timing signal. The two diodes and pulsewidth potentiometer R8 allows the setting of the on and off time without effecting the oscillator's operating frequency. One diode allows only the discharge current to flow through it and the section of R8 that its connected

PARTS LIST FOR THE EXTENDED-PLAY CIRCUIT

- C1—220- μ F, 24-WVDC electrolytic capacitor
 - C2—100- μ F, 25-WVDC electrolytic capacitor
 - C3—1- μ F, 100-WVDC Mylar capacitor
 - D1, D2, D3—1N914 general-purpose signal diode
 - D4—1N4738, 8-volt, 1-watt Zener diode
 - U1—LM324 quad op-amp, integrated circuit
 - Q1, Q2—2N3904 or 2N2222 NPN general-purpose transistor
 - Q3—2N3055 power NPN transistor
 - R1, R2, R3—1,000-ohm, $\frac{1}{2}$ -watt resistor
 - R4, R6—4700-ohm, $\frac{1}{2}$ -watt resistor
 - R5—10,000-ohm, $\frac{1}{2}$ -watt resistor
 - R7—470-ohm, $\frac{1}{2}$ -watt resistor
 - R8—50,000-ohm, potentiometer
 - S1—Single-pole, single-throw (SPST) toggle switch
- Perfbord, cabinet cassette recorder, 11- to 15-volt power source, IC socket, etc

to. The other diode, and its portion of R8, sets the charge time for the timing capacitor, C3. Since the recorders speed is controlled by the precise off/on timing of the oscillator, a simple voltage-regulator circuit is included (Q1, R3, and D4).

Connecting the speed control to most cassette recorders is a simple matter of going into the recorder and disconnecting either of the motor's power leads (the ground or common side might be best) and connecting the recorder through a length of small shielded cable to the control circuit. In some recorders a remote input jack is furnished to remotely turn on and off the recorder.

Before going in and modifying a recorder with a remote jack, try connecting the circuit to the remote. Check the polarity at the remote terminals and connect the circuit as Fig. 1 indicates. I found that about half of the recorders with an external remote input work with the circuit, without going into the machine at all.

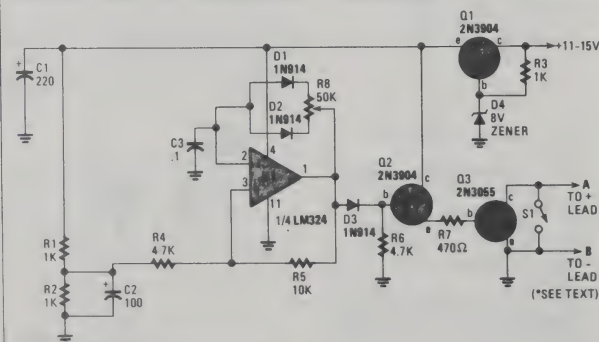


Fig. 1—The Extended-Play Circuit

If the oscillator's positive going portion of the timing pulse is set to close at 25% of the total timing period, the cassette should be operating at about $\frac{1}{2}$ or $\frac{3}{4}$ of its normal speed. Switch, S1 is needed to get the motor started when operating at lower speeds. It can also be used to speed up the rewind and fast forward functions of the recorder.

Even though the circuit won't start the motor at its lower operating speeds, it will (once started) maintain a reasonably steady motor speed. But don't expect hi-fi reproduction at the lower speeds. To obtain the best results with the circuit and selected cassette recorder, expect to spend some time experimenting with the combination.

Sound-Activated Tape Switch

The next cassette-recorder accessory circuit is one that can serve many fun-time needs. First, the circuit can set up a cassette recorder to automatically turn on when a sound or noise is present and start recording. Another use, which could be the most-valuable application for the circuit, is when the sound activated switch is used to turn on a cassette player especially set up so that it turns the combination into a burglar-alarm detector and sounder.

The heart of our multifaceted audio switch (as shown in Fig. 2) is the LM324 quad op-amp. Op-amps U1a and U1b are connected in tandem to amplify the sounds picked up by the detector's mike. The amplified audio voltage, output at pin 7 of U1b, is fed to a voltage-doubler circuit, consisting of D1 and D2.

The elevated voltage from the doubler

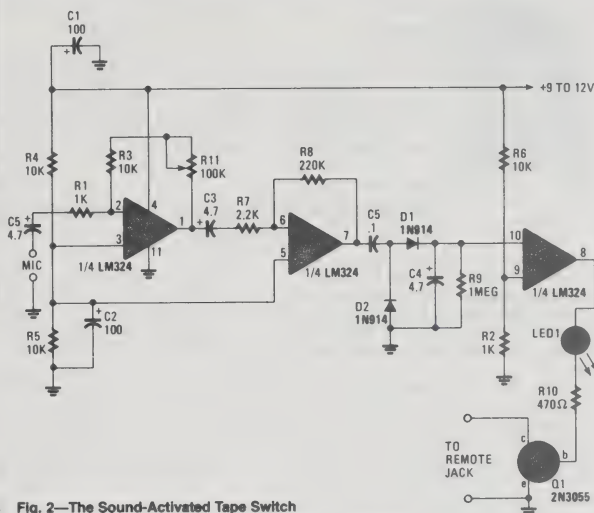


Fig. 2—The Sound-Activated Tape Switch

circuit is input to the positive input of op-amp U1c (which is operating as a simple comparator circuit). The other input of U1c is connected to a voltage divider that sets the switching point for the DC signal voltage, to turn on when the signal level is greater than about 1.5 volts.

As the comparator switches on, its output at pin 8 goes positive and supplies a forward bias to turn on D3 and Q1, which in turn, starts the recorder. The RC combination of C4 and R9 sets the cassette's run time after the input sound has ceased, preventing the recorder from chopping up or turning off between closely-spaced sounds or words picked up by the mike. The delay time is roughly 6 to 8 seconds. R11 sets the circuit's gain.

Using the circuit is simple. Connect a low-impedance cassette mike to the amplifier's input, and connect the output of Q1 to the cassette's remote input, or internally as in the first circuit. Supply 9 or 12-volts DC to the circuit (either a battery or AC-operated supply) and set the recorder to record. Talk to the circuit and adjust the amplifier's gain with R11 for the desired sensitivity.

Now to use the circuit and recorder as a burglar alarm, a specially-recorded tape is required, which you can make yourself. One scheme in making the special tape is to use the sound of a vicious barking dog to run on the tape for a minute or so with a silent time period between each barking session for about 15-seconds.

The silent gap will allow the circuit to shut down the cassette and be ready for

another intruder to make noise, starting the barking again. The complete tape should be filled with a time period of the dog barking and the 15-second spacing and dog barking, etc. With a little imagination the circuit can be used with a cassette and a specially-recorded tape to automatically scare tricksters on Halloween.

Telephone Auto-Record Circuit

The circuit in Fig. 3 turns the cassette recorder into a poor man's secretary—keeping perfect notes of all telephone

(Continued on page 28)

PARTS LIST FOR THE SOUND-ACTIVATED TAPE SWITCH

- C1, C2—100-μF, 16-WVDC electrolytic capacitor
- C3, C4, C5—4.7-μF, 25-WVDC electrolytic capacitor
- C6—1-μF, 100-WVDC Mylar capacitor
- D1, D2—1N914 general-purpose signal diode
- D3—Light-emitting diode
- U1—LM324 quad op-amp, integrated circuit
- Q1—2N3055 (or similar) NPN power transistor
- R1, R2—1,000-ohm, $\frac{1}{2}$ -watt resistor
- R3, R4, R5, R6—10,000-ohm, $\frac{1}{2}$ -watt resistor
- R7—2200-ohm, $\frac{1}{2}$ -watt resistor
- R8—220,000-ohm, $\frac{1}{2}$ -watt resistor
- R9—1-Megohm, $\frac{1}{2}$ -watt resistor
- R10—470-ohm, $\frac{1}{2}$ -watt resistor
- R11—100,000-ohm, potentiometer, IC socket, perfboard, terminals, microphone, etc.

PARTS LIST FOR THE TELEPHONE AUTO-RECORD CIRCUIT

- C1—.05-μF, 100-WVDC Mylar capacitor
- C2—.01-μF, 100-WVDC Mylar capacitor
- Q1—2N4360 (or similar) P-channel field-effect transistor (FET)
- Q2—2N2222 or 2N3904 general-purpose NPN transistor
- Q3—2N2102 or 2N3725 NPN silicon transistor
- R1, R2—10-Megohm, $\frac{1}{2}$ -watt resistor
- R3—22-Megohm, $\frac{1}{2}$ -watt resistor
- R4—39,000-ohm, $\frac{1}{2}$ -watt resistor
- T1—2,000-ohm, to 10,000-ohm, mini audio transformer
- Perfboard, mike and remote plug to match cassette recorder used, etc.

By Charles D. Rakes

CIRCUIT CIRCUS

Convert from dot and bar indicators to numerical readouts

□ This month's circus offers two different, and hopefully useful, circuits designed around the 3914 dot/bar display driver. That chip is normally used in a number of circuits where a row of 10 LED's or low-current incandescent lamps are used to indicate the analog-voltage level presented to its input.

When a row of LED's are connected to the chip, they can be used to indicate anything from a change in temperature to circular motion in RPM's, to voltages, or just about anything that can be measured and indicated through a dot arrangement or a glowing bar of light.

The circuit in Fig.1 goes one step beyond the dot/bar display. Using a number of inexpensive silicon diodes to interface the 3914 to an easier to read seven-segment LED number display, instead of counting the number of lit lamps to determine the input level, a numerical value is read out on the seven-segment display. The chip/seven-segment display combination can be used with most existing circuits where a dot or bar display is used.

The display circuit, as shown, can stand alone and operate as a two-range, single-digit DC voltmeter, or can be used strictly as a display-converter circuit. As an easy-to-read, ultra-simple voltmeter, the circuit does a good job.

Dot/Bar to Numerical Converter

The input to U1 at pin 5 responds linearly to a positive DC voltage. And with the component values shown in the schematic diagram, the input voltage range is 0 to 1.2 volts. If a voltage is fed directly to U1 at pin 5, bypassing the multiplier resistors (R1 and R2), a voltage of about .12 volts generates digit "1" on the display, and a level of 1.2 volts generates a "0" reading. By adding R1 or R2 and the cal-

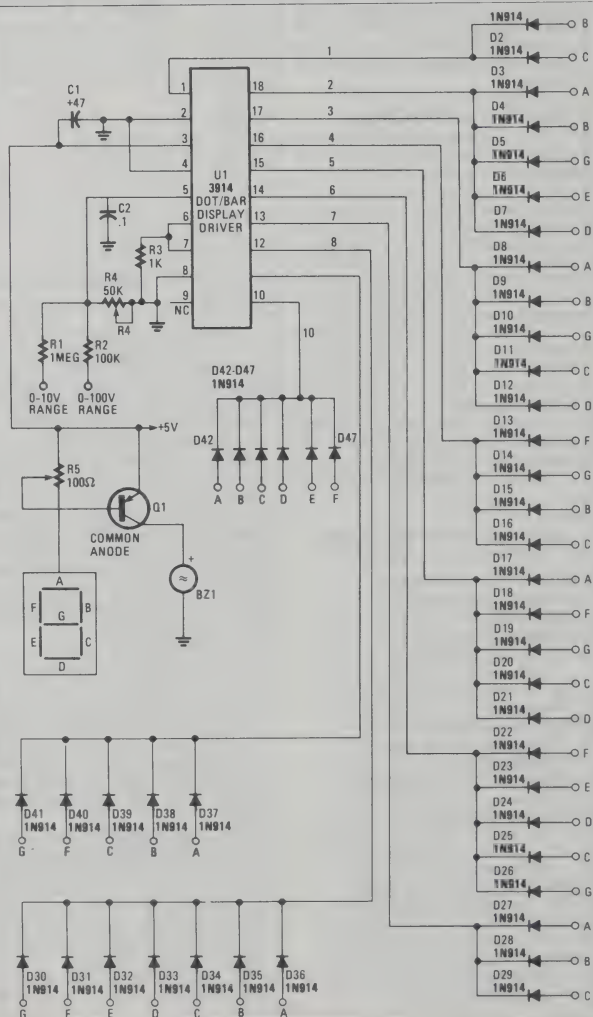


Fig. 1—The interface circuit, using a 3914 dot/bar display driver coupled with several inexpensive diodes, can be used in circuits where a row of 10 LED's or low-current incandescent lamps are used to indicate an analog voltage level—allowing the dot/bar display to be replaced by a numerical readout. And it can stand alone, operating as a two-range, single-digit DC voltmeter.

1.0 volt, 1.9 to 2.0 volts, and on through 0.

As the output of the chip goes from one digit to the next, there's a time when two outputs are in transition and on at the same time. This condition is normal and does not cause any problems with the dot or bar readout function, but when connected to our seven-segment readout, causes an incorrect number of segments to be lit during that few millivolt input change. This condition, if known about at the time of transition will cause little or no problem in using the voltmeter, and with a simple circuit added to sound off when the readout is changing the minor problem is solved.

Transistor Q1 is connected to monitor the display current through the common-anode connection of the LED readout, and with R5 can be calibrated to only activate the piezo sounder when the chip outputs are in a transitional mode. With a variable DC voltage connected to the circuit's input, and an accurate voltmeter monitoring the output, observe the LED readout as the voltage is increased from one volt to two. At the point of changing over from a readout of "1" to "2," the LED readout will have several erroneous segments lit. Hold that condition and adjust R5 to produce an output from the piezo sounder. Bring the voltage supply on up to cause a "2" reading on the display and sound should cease. The audio tone is an excellent reminder that a change in input is occurring.

Usually all that you will ever hear out of the sounder is a short beep as the voltage changes at the input, and very seldom will the input voltage ever remain within the very narrow millivolt range to cause the sounder to remain on for any period of time. With or without the audio reminder circuit the simple voltmeter can be a fun project to build and apply to that special need.

Dot/Bar to Audio Converter

The second circuit (shown in Fig. 2 and also built around the 3914 chip) is designed to replace the visual readout—be it dot, bar, or digital—with a distinct audio tone for each digit. This output indicator circuit can also be used with other existing 3914 circuits to replace the dot-display arrangement, or as an audio digital voltmeter.

A major reason that that circuit is important to me, and possibly will be to others, is that it can serve as a simple voltmeter that can be a helpful tool for our sightless friends who share our hobby. Also it can be a useful testing tool for anyone who is taking a rough voltage measurement where it is difficult to see both the voltmeter and circuit under test at the same time. Or the circuit can be used as a voltage alarm to sound off if a major voltage change occurs.

The input circuitry is similar to the one in Fig. 1, and can be set up and used in the same manner. A VCO PLL IC, a 566, is used to generate the ten different tones. A switch, S11, and capacitor C2 are added to allow the voltage reaching the chip's input to rise slowly so that the output tones can be easily counted to help in using the audio meter. S1-S10 are helpful to determine which tone is being sounded and what digit it represents.

The frequency range of the ten tones is set by the values of C5 and R38 through R47, and with the values given the tone for digit #1 is about 30Hz and #0 near 2400Hz. With practice the tones can automatically be heard as a particular digit just

PARTS LIST FOR THE DOT/BAR TO NUMERICAL CONVERTER

SEMICONDUCTORS

D1-D47—IN914 silicon signal diode
U1—3914 DOT/BAR display driver
DISP1—Seven-segment, common-anode light-emitting diode display
Q1—2N3906 PNP general-purpose transistor

RESISTORS

(All resistors ½ watt, 5% units unless otherwise noted.)

R1—1-Megohm
R2—100,000-ohm
R3—1000-ohm
R4—50,000-ohm potentiometer
R5—100-ohm potentiometer

CAPACITORS

C1—47-μF, 16-WVDC electrolytic
C2—0.1-μF, 100-WVDC Mylar

ADDITIONAL PARTS AND MATERIALS

BZ1—Solid-state Piezo buzzer
Printed-circuit board or perboard materials, enclosure, 5 volt power source, IC sockets, hardware, solder, wire, etc.

as we learn the International Morse Code.

The ten switches, S1 through S10, can be placed in a row to correspond with the digits they represent. If a tone or it's represented number is in doubt the corresponding switch can be pushed to confirm or locate the digit. When the correct switch is pressed the tone will cease, indicating the digit being heard.

As you can see, the electronics hobby is one area where no matter how far-fetched or bazaar your idea may seem, it's still worth looking into. Who knows, that unnatural scheme that today is looked upon as hair-brained, may tomorrow be heralded as the "technological breakthrough" of the century.

Until next month put that old bean to use and build a circuit or project to help someone with an electronic problem. And may the flow be with you. ■

CIRCUIT CIRCUS

(Continued from page 9)

When the needle and penny assembly feel cool to the touch, use contact cement to attach the penny to the center of the speaker's cone with the needle sticking out in front. Since the penny covers the majority of the speaker's cone, the pickup responds only to the vibration transferred through the needle and not to sounds through the air. The pickup assembly can be housed in a plastic or metal tube to protect it and the user from damage.

The electronics of the circuitry can be built on a piece of perfboard and housed in a small metal or plastic cabinet. No special construction techniques are required, just use a good layout and wiring scheme.

In searching out a low-level tick or mechanical vibration, touch the pickup (needle) against the suspected area and set the amplifier's gain to a comfortable listening level. A 2000-ohm or better set of headphones will work fine with the circuit. Have fun!

Maybe you too can become world famous by using one of the electronic detection circuits to crack a big case. Who knows? ■

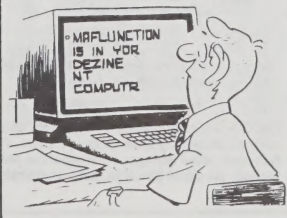
CIRCUIT CIRCUS

(Continued from page 21)

outputting a positive voltage, which then lights LED1. Removing body heat from D2 causes its temperature to decrease to the level of D1, forcing the circuit to revert to its original condition.

Setting up the circuit is easy. Turn R5 until LED1 just goes out. If the ambient temperature surrounding the two diodes (D1 and D2) is below 98.6-degrees (average body temperature), and D2 is touched by a warm live body, its temperature rises, and LED1 should light. If the ambient temperature is above 98.6-degrees, touching diode D2 tends to cool it and LED1 remains off. But by cooling D1 with a touch, the voltage at pin 2 goes below the voltage at pin 3, turning LED1 on.

Reach out and touch an electronic pet today; and until the next time, enjoy the Circus. ■



CIRCUIT CIRCUS

(Continued from page 2)

plug connections.

We tap into the telephone line by connecting our IR transmitter circuit in series with either the tip or ring. When the telephone is off-hook current will flow through the diode bridge polarity protector and supply the power for the IR transmitter. The phone's audio information is taken off the line by transformer T1. The 1000-ohm winding of the transformer connects to a two-stage transistor audio

amplifier/modulator. The circuit shown worked just fine at our location, but a 2000-ohm potentiometer could be added to the input of the two-stage amplifier to control the modulation level; and another potentiometer could be added in place of R3 to adjust the IR's idle current.

To increase the operational range of the IR transmitter, try experimenting with different lenses to better direct the light toward the receiver. How about adding an IR filter?

Earlier I invited you to write offering suggestions, asking for help, and (most

important) offering unusual circuits that you had assembled and tested to this column—*Circuit Circus*. Please address all correspondence to: Charles D. Rakes, Circuit Circus, HANDS-ON ELECTRONICS, 500-B Bi-County Boulevard, Farmingdale, New York 11735. In almost all cases your mail can not be answered personally, because the volume of it arriving at this office makes that task impossible. However, I do survey all the mail and in one way or another most of it will be answered in future columns. Let's hear from you! ■

CIRCUIT CIRCUS

(Continued from page 25)

calls coming in and going out from the same phone or phone line. And to top it off, the circuit requires neither a battery or AC supply to make it work. A really cheap circuit indeed.

Two voltmeter readings are necessary before the circuit can be placed in service. First the polarity of the phone lines must be determined and then connected to the circuit as shown in the schematic diagram. The polarity of the remote input leads on the cassette recorder must be checked out and connected to the circuit as shown. Set the recorder to the record position and when the telephone is taken off hook the recorder starts to record all.

The circuit's operation is simple: When

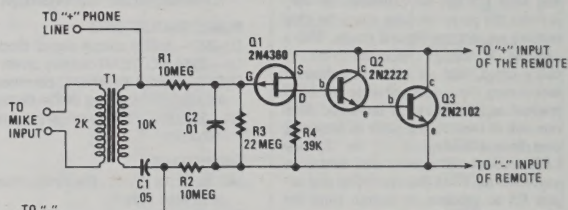


Fig. 3—The Telephone Auto-Record Circuit

the phone is on hook, in most cases, the voltage across the phone lines is about 48-volts DC; when taken off-hook, the line voltage drops below 10 volts. When the line voltage is near 48-volts, the FET is biased off and no current can flow through

Q2 and Q3, but when the receiver is off hook the voltage drops, allowing Q1 to conduct turning on Q2, Q3, and the cassette recorder. Try one or more of the cassette control circuits and have fun until next time. ■

CIRCUIT CIRCUS

(Continued from page 15)

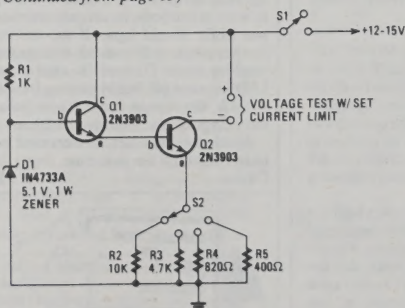


Fig. 5—This circuit allows you to test unmarked semiconductor components without damaging them in the process. You can test low-voltage Zeners to find their rated voltage; determine the polarity of LED's and unmarked diodes; do diode junction tests on transistors to determine their type.

PARTS LIST FOR THE SEMICONDUCTOR TESTER

- D1—1N4733A, 5-volt, 1-watt Zener diode
- Q1, Q2—2N3903 general-purpose NPN silicon transistor
- R1—1000-ohm, 1/4-watt, 5% resistor
- R2—10,000-ohm, 1/4-watt, 5% resistor
- R3—4700-ohm, 1/4-watt, 5% resistor
- R4—820-ohm, 1/4-watt, 5% resistor
- R5—400-ohm, 1/4-watt, 5% resistor
- S1—Single-pole, double-throw switch

and unmarked signal diodes; do diode-junction tests on transistors to determine their type, test electrolytic capacitors and even determine lead polarity.

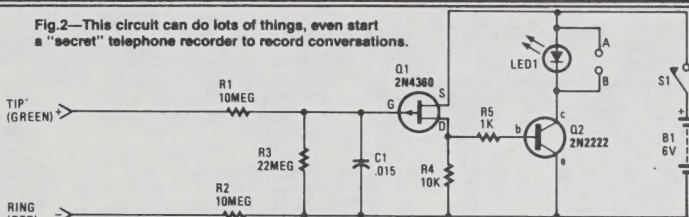
This is another user-friendly type circuit that can be built as a handy test unit for future use around the experimenter's work bench. Good luck with all of your circuit adventures. ■

CIRCUIT CIRCUS

(Continued from page 3)

age keeps Q1 in the cut-off condition, allowing no current to flow through resistor R4, hence Q2 remains off. (Resistors R1 and R2 keep the solid-state switch circuit from causing any problems with the telephone's central-office equipment.) When a phone is taken off-hook, the line voltage (tip to

Fig. 2—This circuit can do lots of things, even start a "secret" telephone recorder to record conversations.



ring) drops to 10-volts or less, which forces Q1 to turn on, which in turn causes Q2 to trigger LED1, or a relay which might be used in lieu of LED1.

Another simple telephone project is the "in use" indicator shown in Fig. 3. This circuit functions as a line-current sensor and can be connected in series with either of the phone lines. For the circuit to indicate an "in use" status for all phones on a single line, it must be connected in series with the phone line before, or ahead of all phones on the line. Since the power for the circuit is supplied by the phone company, a circuit could be added to each phone as an off-hook indicator.

Once in a while it would be handy to

amplify or record a telephone call, and you can do it with the simple circuit shown in Fig. 4. The 8-ohm secondary winding of a miniature transistor output transformer is connected in series with either of the telephone lines. The 1000-ohm primary winding can feed either a cassette recorder or an audio amplifier.

PARTS LIST FOR FIG. 2

- B1—6-volt battery (four AA cells)
 - C1—0.015- μ F, 100-WVDC Mylar capacitor
 - LED1—COX21 Flasher LED, Radio Shack 279-0388
 - Q1—2N4380 or 2N4342 FET
 - Q2—2N2222 NPN silicon transistor
 - R1, R2—10-Megohm, $\frac{1}{4}$ -watt, 10%, resistor
 - R3—22-Megohm, $\frac{1}{4}$ -watt, 10%, resistor
 - R4—10,000-ohm, $\frac{1}{4}$ -watt, 10%, resistor
 - R5—1,000-ohm, $\frac{1}{4}$ -watt, 10%, resistor
 - S1—SPST switch
- Wires, cabinet, solder, etc.

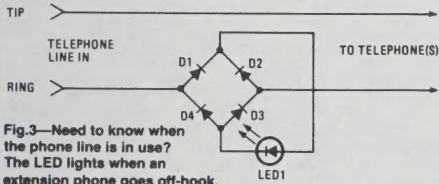


Fig. 3—Need to know when the phone line is in use? The LED lights when an extension phone goes off-hook.

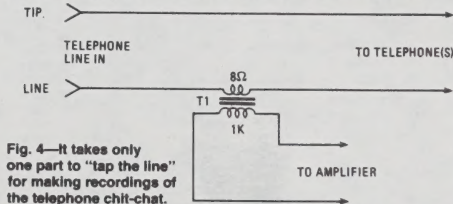


Fig. 4—It takes only one part to "tap the line" for making recordings of the telephone chit-chat.

- PARTS LIST FOR FIG. 3
- D1, D2, D3, D4—1N4148 or 1N4149 diodes
- LED1—Light emitting diode
- T1—Transformer, audio output, 8-ohm secondary, 1000-ohm primary, 8-ohm secondary

CIRCUIT CIRCUS

(Continued from page 17)

PARTS LIST FOR THE HIGH-POWER SEMICONDUCTOR TESTER

- B1—Battery, 6-volt (see text)
 - LED1, LED2—Jumbo red light-emitting diode
 - R1—1000-ohm, $\frac{1}{4}$ -watt, 5% resistor
 - R2—100-ohm, $\frac{1}{4}$ -watt, 5% resistor
 - R3—330-ohm, $\frac{1}{4}$ -watt, 5% resistor
 - R4—1500-ohm, $\frac{1}{4}$ -watt, 5% resistor
 - R5—5000-ohm, $\frac{1}{4}$ -watt, 5% resistor
 - S1—S3—Normally open, momentary contact, pushbutton switch
 - S4—Double-pole, 3-position (2P3P) rotary switch
- Printed-circuit or perboard materials, C-cell battery holder (four cell type) and snap-on connector, jack or clip lead, enclosure, wire, solder, hardware, etc.

any voltage up to the voltage of the battery used. If, for example, you desired your voltmeter to read 5 to 15-volts full-scale on the 0 to 10-volt scale, you would simply set the 25,000-ohm potentiometer (R1) to insert 5-volts (reverse polarity) in the meter circuit.

A higher- or lower-voltage battery can be used to meet whatever expanded voltmeter scale you might need. There's only one drawback to the circuit, and normally

it won't be a problem in most applications. If the meter is connected to a circuit that's sensitive to a reverse voltage, some damage might occur. But, when making normal predetermined voltage measurements, the circuit performs just fine. If you don't mind introducing a small voltage error, place a diode in series with one of the meter leads.

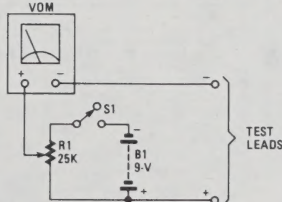


Fig. 5—VOM Range Extender

PARTS LIST FOR THE VOM RANGE EXTENDER

- B1—Battery, 6-volt type
 - R1—25,000-ohm, potentiometer
 - S1—Single-pole, single-throw (SPST) toggle switch
- Perboard material or barrier strip, 6-volt transistor radio battery holder and snap-on connector, wire, solder, hardware, etc.

(Continued from page 19)

There's only one way to have fun with those two circuits, and that is, of course, to dig in and experiment with each one until you obtain the sound effect that you desire. And there is no rule against adding your own circuitry to what we have offered. So get to it, and good Luck. ■

RESISTORS

CAPACITORS

ADDITIONAL PARTS AND MATERIALS

IC socket, perfboard or printed circuit materials, etc.

(Continued from page 11)

The number of LED's flashing in a sequential ring can be easily increased to eight by adding another 4001 quad not gate. Just repeat the circuit in Fig. 3 and connect the additional circuit in series with the first (input to output) as an extension of the first circuit. When power is connected to the eight-LED Flasher circuit, four LED's will turn on at once and then flash off with the four remaining LED's coming on. As before, just press S1 and hold closed until all but one LED turns off, and then the LED's will begin their sequential march around in a circle. You can connect as many circuits in series as you like.

Illumination Intensifier

If the light output of the LED's isn't bright enough for you big timers, take a look at the high-intensity driver circuit

Always be careful when working with any potential over 12-volts: many careless people don't have the opportunity to do so any more.

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